THURSDAY, AUGUST 30, 1888.

THEORETICAL GEOLOGY.

Theoretische Geologie. Von Dr. E. Reyer, A. O. Prof. der Geologie an der Universität Wien. (Stuttgart, E. Schweitzerbart'sche Verlagshandlung, 1888.)

IT would be most unfair to compare the work before us with any of the numerous treatises on geological science which have during recent years made their appearance in England, Germany, and France. The author's aim, as defined in his preface, has been not so much to give a well-proportioned summary of the ascertained facts of the science, as to prepare an historical and critical review of the ideas that have been put forward concerning the fundamental principles of geology. To find a parallel to the present essay, indeed, we should have to go back to the "Philosophie der Geologie" of Vogelsang, or even to the works of Lyell and Von Hoff.

Those who are familiar with Dr. Reyer's earlier works —"Die Euganeen : Bau und Geschichte eines Vulcanes," and "Beitrag zur Fysik der Eruptionen und der Eruptiv-Gesteine"—will be prepared to find the problems of geology treated by the author, not only with great fullness of knowledge, but with a remarkable freedom from the influence of traditional modes of thought; and they will not be disappointed by the perusal of the present volume. Since the period when his earlier works appeared, Dr. Reyer has travelled very extensively, and has had the fortunate opportunity of studying those splendid manifestations of terrestrial forces which are found in the Western Territories of the United States. Everywhere the reader of this volume is enabled to profit by these widened experiences of its author.

In his preface, Dr. Reyer expresses a regret that there does not exist in Germany the same class of private students of science as is found in this country; for to the labours of men who have been alike free from the conservative pedantry of the professor and from the shallow pretensions of the mere *dilettante*, he justly ascribes a very great part of the credit of advancing geological science in England. The author instances the names of Hopkins and Herschel, but no one acquainted with the history of geology will fail to add those of Hutton, Sir James Hall, William Smith, Scrope, De la Beche, Conybeare, Lyell, Darwin, Godwin-Austen, Sorby, and a host of others. Regret has sometimes, and not unjustifiably, been expressed that the moulding of geological thought has, during recent years, fallen more completely into the hands of those who may be called professional geologists—a result which is perhaps a necessary consequence of the more specialized nature of the study at the present day; but we trust that the day is very far distant when the advance of geological knowledge in England will be wholly, or indeed mainly, dependent on the labours of those engaged in teaching or in making geological maps.

Dr. Reyer seems to hold that it is almost impossible that physical geology and palæontology should be cultivated and taught by the same individual, and he advocates the practical divorce of these two branches of science. It would not be difficult to point out objections to this course and serious difficulties in the way of its adoption; such difficulties must arise in the case of rocks which are wholly or in part made up of the remains of organisms, and in connection with questions concerning the physical conditions under which certain rock-masses have been accumulated, when these can only be adequately discussed after the nature of the organic remains inclosed in them has been taken into account. Nevertheless, no one will contest the author's right to limit the scope of his own discussions to purely physical problems; and, indeed, Dr. Reyer has found himself compelled to confine the present volume to the questions more or less directly connected with igneous activity upon the globe, leaving the problems more especially connected with the waters of the globe and those of cosmical geology for future sections of the work.

Commencing with an account of the explosive action of volcanoes and of the circumstances connected with the outflow of lava from them, the author, enlarging the scope of the inquiry pursued in his former works, proceeds to discuss the physical problems involved in these remarkable phenomena. Observations made in recent years upon the absorption of gases by molten metals and other substances, and the phenomena attending the escape of the gases from such magmas, are fully described; and the bearing of these facts upon the problems of vulcanology are clearly pointed out. English readers will be pleased to find a German treatise in which "Elevation-craters" have finally disappeared, and scarcely less gratified to read our author's conviction, very clearly expressed, that the modified characters of the older lavas, as well as the apparent deficiency of volcanic products among the older geological formations, are due to secondary changes, and that there is no real ground for the supposed absence of granitic rocks among the igneous products of the younger geological periods. We are glad, too, to notice that Dr. Reyer recognizes the value and importance of the observations of Scrope and Darwin upon the banded structure produced in viscid lavas; though we think he fails to appreciate the full bearing of these facts when he afterwards proceeds to discuss the important question of the origin of foliation.

In the discussion of the problems connected with the folding and faulting of rock-masses, during mountain-making, Dr. Reyer exhibits the fullest knowledge and impartiality. To the labours of Henry Rogers and other American geologists, who nearly fifty years ago worked out the structure of the Appalachians with such remarkable skill and geological insight, he renders full justice, and not less to the observations of their able successors who have in recent years shown what singular variations from the normal structure of mountain masses exist in the Western Territories of their country. It is a fortunate circumstance that the eastern and western portions of the United States should present such perfect examples of the diverse structures found in mountain ranges, and that the geologists of that country have proved themselves so capable of dealing with the grand but difficult problems presented for their study. But at the same time our author has fully set forth the value of the researches of Lory, Baltzer, Heim, and others, who have shown that

the structures found in the Appalachians are equally characteristic of the Alps, and the more denuded mountain chains of Central and Northern Europe. In explaining the causes of regional or mechanical metamorphism, Dr. Reyer fully appreciates the importance of the experimental researches of Tresca, Daubrée, and Spring; while he fails not to point out the important additions and confirmation of the theory of "mechanical metamorphism," which are furnished by the microscopical investigations of Lossen, Lehmann, and other recent authors on the subject.

Seismology, the study of earthquake phenomena, is usually treated by the writers of text-books as a branch of vulcanological science; but we agree with the author in regarding it rather as connected with the great movements of earth-masses. It finds an appropriate place in this work between the chapters dealing with dislocations of the earth's crust, and those devoted to the great secular movements of the earth's surface.

In a work like the present, devoted to a discussion of problems of the greatest difficulty, many of which are far from ripe for solution, some of the views of the author will be sure to challenge criticism and others to provoke dissent. Every unprejudiced reader will admit, however, that Dr. Reyer's presentation of his views upon these problems is characterized not only by much originality of thought, but by a studious fairness of manner. The citation of original authorities in every case is a most praiseworthy feature of the work, and those writers from whom the author differs have no cause to complain, as is too often the case, that he has not even tried to understand their arguments. Nowhere does there exist such a rich storehouse of facts and observations bearing upon the great questions of geology as in the volume before us, and we cannot doubt that the completion of Dr. Reyer's important work will mark an epoch in the history of the science, and at the same time constitute an important starting-point for further advances.

J. W. J.

A GUIDE TO THE LICK OBSERVATORY.

Hand-book of the Lick Observatory of the University of California. By Edward S. Holden, LL.D. (San Francisco: The Bancroft Company, 1888.)

THERE are two classes of readers to whom this little book ought to be especially welcome—namely, those who propose to visit California, and those who do not so propose. Travellers will miss from it no useful item of information. They are told where to lodge, what to wear, how to get themselves conveyed to their destination, what to look at and admire. They are put, moreover, in the proper frame of mind for approaching an astronomical sanctuary. The coldest and dullest can hardly under such guidance remain utterly apathetic and unintelligent. The general interest of the work, on the other hand, is sufficiently attested by a glance at the table of contents. It includes a "Sketch of the Life of James Lick," the founder of the Observatory, a history of the institution, descriptions of the buildings and instruments, with sections on "The Work of an Observatory," "Telescopes," "Astronomical Photography," "Clocks and Time-keeping," and "The Principal Observatories of the World." On none of these subjects are there many, on some there is no one entitled to speak with greater authority than Prof. Holden. Nor is there a second astronomer in the world whose utterances—so far as they are an index to his intentions—are at present of higher moment to science. The future course of observation largely depends upon his use of the vast opportunities placed in his hands. A colossal experiment is being tried at Mount Hamilton; its upshot will lay down the lines of astronomical effort for many a decade to come. For results govern the star-gazing, no less than every other section of mankind.

Prof. Holden vainly, we fear, seeks to disabuse the public of its fixed idea that "an astronomer's business is to watch the heavens go by and to 'make discoveries.' Exactly what these discoveries are," he goes on to say, "is usually not stated, but unless a sufficient number are forthcoming the astronomer is held to be blameworthy." The Lick Observers, however, possess a unique advantage in the value of their negative results. "What we cannot see with our telescope, the most powerful of all, in our elevated situation, the best in the world, need not be looked for with inferior telescopes in less favoured situations."

Celestial photography is evidently designed to be vigorously prosecuted on Mount Hamilton. "One of the principal objects of the Observatory," we are told, "will be to make a photographic map of the heavens, by means of the large telescope and its photographic objective." If carried out on the scale which appears to be indicated, this will indeed be a gigantic undertaking. Its plan is doubtless not yet definitely laid down, but exposures of three hours are spoken of. On Mount Hamilton, two hundred nights in the year—just double the low-level allowance—can be counted on as fit for such work; yet even so, twenty-five years should elapse before the whole sky could be *once* covered by plates each embracing four square degrees, and exposed during three hours. And the resulting priceless record would lose, unless obtained in duplicate, great part of the value properly belonging to it.

The time-service of the Lick Observatory has been for some time completely organized. Every railway-clock in the Southern Pacific States is now regulated from Mount Hamilton. Any watch in San Francisco can be set by the beats of the Lick standard clock, rendered audible by telephone at a distance of sixty miles. The time distributed is the "Pacific standard," which is 6m. 34·3s. faster than the Mount Hamilton local time. Numerous plans and illustrations enhance the usefulness of the "Guide to the Lick Observatory."

A. M. C.

OUR BOOK SHELF.

Curve Pictures of London for the Social Reformer. By Alex. B. Macdowall, M.A. (London: Sampson Low, 1888.)

THIS little volume ought to be of great service to all who interest themselves practically in questions relating to social reform in London. It presents by means of diagrams a large amount of trustworthy information about population; density of population; birth, marriage, and death rates; early marriages; death by disease; suicides; drunkenness; licensed houses; apprehensions; felonies;

pauperism; education; illiteracy; prices of commodities; and prices of wheat. Students who may wish to know the recent history of London with regard to any one of these subjects will at once find what they want by turning to the diagram or diagrams referring to the matter. Opposite each diagram are short notes indicating clearly and concisely what the curves appear to teach, and directing the reader to the original sources from which the facts are taken. It is impossible to turn over these pages without feeling, as the author does, that if some improvement of the social condition of London is discernible it is, after all, but meagre. Probably, too, most people who make themselves familiar with the results he has so carefully classified, and rendered so easily intelligible, will agree with him that in dealing with the social problem we as a people are apt to think too much about cure, and too little about prevention. "Year by year," says Mr. Macdowall in his interesting preface, "we reap, somewhat sadly, our weedy crop; but we leave the weed-roots in the ground. To use another figure, we contend in a vigorous way with the waters of a domestic deluge, but omit to turn off the tap from which they come."

A System for the Construction of Crystal Models. By John Gorham, M.R.C.S.Eng., &c. (London and New York: E. and F. N. Spon, 1888.)

THE author of this book expounds an ingenious method of making models in paper by plaiting together three or four strips cut into the form of a succession of the crystal faces. The book consists mainly of figures, which show how these plaits are to be drawn, and the order in which they are to be interwoven for some of the primitive forms in the different systems.

It does not appear that the models are more easily or neatly made by this than by the more familiar methods, but they have one real advantage in their portability, since they may at any time be unfolded into a flat sheet. The method would, however, be somewhat awkward when applied to complicated combinations.

Some of the simple forms are omitted in the descriptions, *e.g.* the icositetrahedron, pentagonal dodecahedron, &c., and it is hardly necessary to remark that the four-faced cube is not a form assumed by some varieties of quartz (p. 8). We hesitate to believe the author serious in his suggestion that a natural cube may actually grow by plaiting itself from three zones of molecular laminæ, "each endowed with a force compelling it to bend at a right angle at given intervals."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Functionless Organs.

I HAVE only just seen NATURE for August 16 and 23 (pp. 364 and 387). In both these there are letters which attribute to me personally the assertion that the electric organs in "the skate" are functionless, and are "on the way to use"—not aborted or degenerated from former use. I made no such assertion. My letter on the subject referred to a verdict given on this question in respect to one particular species (*Raia radiata*) by Prof. Ewart in NATURE of July 26 (p. 310). I refer Prof. Ray Lankester to the paper of Prof. Ewart, communicated to the Royal Society through Prof. J. Burdon-Sanderson. As the result of an elaborate argument, founded on anatomical details, the author concludes that the "cups of *Raia radiata* are in process of being elaborated into more complex structures"; and again, "that the electric organ of *Raia radiata*, notwithstanding its apparent uselessness and its extremely small size, is in a state of progressive development."

This is not my conclusion, but the conclusion of an expert, who gives his reasons, and differs from Prof. Ray Lankester in having, apparently, no preconceived theory to support.

If the doctrine of evolution be true—that is to say, if all organic creatures have been developed by ordinary generation from parents—then it follows of necessity that the primæval germs must have contained potentially the whole succeeding series. Moreover, if that series has been developed gradually and very slowly, it follows also, as a matter of necessity, that every modification of structure must have been functionless at first, when it began to appear. On this theory it seems to me to be not a matter of argument, but a matter of certainty, that all organic nature must have been full of structures "on the rise," as well as of others on the decline.

Why is this not recognized? Because organs "on the rise" cannot be due to utility as a physical cause, but must be due to utility as an end yet to be attained. This is what I mean by a "prophetic germ." We now know that Darwin resisted and rejected this idea, at least at one time of his life, as fatal to his own theory of natural selection. And so it is, if natural selection is made to account for structures before they are presented for selection to act upon. But this is obviously nonsense. Things cannot be selected until they have been first produced. Nor can any structure be "selected by utility in the struggle for existence" until it has not only been produced, but has been so far perfected as to be actually used.

If Prof. Ray Lankester will explain how "natural selection" can act upon "congenital variations" which he calls "non-significant"—*i.e.* which are not yet of any actual use—and if he will explain how this action can afford "the single and sufficient theory of the origin" of (as yet) useless variations, he will have accomplished a great triumph in logic and philosophy.

Meantime, I adhere to that view of all organs which is indelibly impressed on our very forms of speech, and is notably expressed in Prof. Burdon-Sanderson's letter in NATURE of August 23. He speaks of electric organs as "an apparatus for producing electric discharges." This is exactly correct. They are "apparatuses" for a special purpose or function; and like all other apparatuses, they have to be prepared through embryotic stages in which they are not capable of use. I have been long looking for some actual case in which experts should recognize an organ "on the rise." Prof. Ewart's is the first I have seen. I am not responsible for his facts, or for his reasoning. But the mere fact of such a view being taken by an eminent man in a responsible position is a circumstance highly significant.

The recognition of even one case will be the recognition of a new idea—new, at least, in its application, and new in its wide significance of interpretation. It will be the counterpart in actual observation of that strategic movement in abstract reasoning which has recently led Mr. Herbert Spencer to expose the fallacies involved in the phrase "natural selection," and in his own neater and adroiter form of it, "survival of the fittest."

ARGYLL.

I HAVE read with much interest the report in NATURE of July 26 (p. 310) of Prof. Ewart's very remarkable paper on the electric organ of the skate, and the Duke of Argyll's letter on the same subject in NATURE of August 9 (p. 341). The Duke is manifestly right, that a single proved instance, such as Prof. Ewart here endeavours to make out, of an organ which has been evolved, or is in process of evolution, while not in a state of functional activity, would be sufficient to disprove Darwinism as a complete theory; for if all perfectionment is due to the two causes of exercise through habit and natural selection among variations, it is obvious that no improvement can be effected which is not immediately useful.

I believe that the animal kingdom, and in all probability the vegetable kingdom also, are full of organs which cannot have been evolved by anything like a Darwinian process, because their immature states cannot have been in functional activity. In my work on "Habit and Intelligence" (2nd edition, Macmillan, 1879), chapters xvii., xviii., and xix., I have enumerated some of these. The strongest part of the argument is, I think, that derived from the brain of man. It has been pointed out by Wallace, the naturalist who was near anticipating Darwin in the theory of natural selection as applied to the rest of the organic creation, that the brain of savage man has attained a development which is out of all proportion larger than can correspond to the mental development which is united with it—in other words, the brain of savage man is nearly equal to that of civilized man,

while his mental development is very far inferior;—so that, as Wallace remarks, "the idea is suggested of a surplusage of power; of an instrument beyond the wants of its possessor." And if it is true, as I believe it is, that the brain of savage man finds its special activity in the formation and use of language, this does not solve but only transforms the difficulty; for language itself must in prehistoric times have attained a development far in advance of the intellectual wants of those who formed it, because the same languages, with comparatively few additions to the vocabulary and no further grammatical development, still suffice for the wants of their civilized descendants; whereas, on Darwinian principles, language could not be evolved beyond the intellectual needs of those speaking it.

There are also many cases in the lower creation where structure appears to have been developed, not as the result of function but in anticipation of function; just as a ship is built on the land for the purpose of afterwards floating on the water. I cannot occupy your space with details of these, but will enumerate those of which the evidence seems tolerably distinct.

All the Hydrozoa are probably descended from a form resembling the Hydra, between which and the Medusæ there is a gradation, though not quite unbroken. Once the Medusa is produced and swims away from the plant-like stem that bore it, its powers of wandering, and dispersing its eggs widely, will give its species a great advantage in the struggle for existence. But how can any natural selection effect the evolution of the Medusa while it is still imperfect, and sheds its eggs without leaving the parent stem?

Müller, in his "Facts for Darwin," says of the transition from the Zoea to the Mysis form in the metamorphoses of a species of Peneus, or prawn, that "the long abdomen, which just before was laboriously dragged along as a useless burden, now, with its powerful muscles, jerks the animal through the water in a series of lively jumps." The Nauplius, which is the form in which this Peneus leaves the egg, has no abdomen; this is acquired when the Nauplius develops into a Zoea, and consists of segments which appear between the body and the tail of the Nauplius. Müller's account seems to show that this abdomen is developed before it is useful to the animal, and for the purpose of becoming useful further on in its development. It is to be observed that in this case, as in that of the Medusa, the entire evolution goes on amid the same surroundings: unlike the case of Batrachia and most insects, there is no change of the conditions of life to accompany the transformation and to help to account for it. The same remark applies to the development of the star-fish out of the Bipinnaria, and of the sea-urchin out of the Pluteus—two of the most wonderful metamorphoses known.

The development of the lungs of the Batrachian out of the swim-bladder of the fish is an adaptive modification, and presents no special difficulty. But in the cellular and spongy texture of the swim-bladder of many Ganoid fishes, there appears to be a preparation for future transformation into lungs. This, however, is a point on which it would not be right to lay much stress. But it is different with the development of the fin of the fish into the leg of the Batrachian. The intermediate state appears to be preserved in the fin-rays—we can scarcely call them fins—of Lepidosiren. The single fin-ray of Ceratodus has in Lepidosiren lost its membrane, and consequently become inefficient as a fin, without being in any degree efficient as a leg, or acquiring any vestige of a foot; such a change cannot be beneficial to an animal which is still a fish and lives a fish's life; it can be interpreted, so far as I see, only as a preparation for the ultimate development of feet and legs. This development, however, does not appear to have been actually attained by any descendant of Lepidosiren; for its scaly covering, and the peculiarity of its nostrils, go far to forbid the supposition that the Batrachia can be its descendants.

Another instance of the same kind is that of those Ascidian larvæ which are the probable origin of the Vertebrata. Of what use can the dorsal groove and the notochord be to those minute and lowly organized animals themselves? They appear capable of interpretation only as the preparation for a vertebral column and a spinal cord to be afterwards evolved. But the strongest instance of the kind which I know of, except that of the brain of man, is the existence of pneumatic bones (that is to say, bones hollowed out for lightness, like those of flying birds) among Dinosaurians (see Prof. Cope's paper on *Megadactylus probyzelus* as reported in NATURE, vol. i. p. 347). The resemblances of the skeleton appear to prove that birds must be descended from Dinosaurians. No Dinosaurian had the power of flight, yet here is a character useful only to flying animals, and interpretable only as a preparation for a power of flight to be afterwards evolved.

Were a competent anatomist and morphologist to search for them, the entire organic world would probably be found to be full of such instances of what I call structure in anticipation of function. JOSEPH JOHN MURPHY.

Belfast, August 22.

IT is evident from the letter of the Duke of Argyll under this heading in your issue of August 9 (p. 341), that he has altogether misconstrued some of the main biological principles which Darwin promulgated; and it also appears as if the entire neglect of certain important items which received due consideration in the "Origin of Species" is either done with purpose, or else is simply an effect of obscuration. In either case, the fallacious interpretation may be due to the polemical style in which his Grace is usually wont to distinguish himself, and the strong bias imported into the treatment has rendered a true representation of the conclusions he assails altogether impossible.

Exception must be taken to the very setting forth of the premises of the Duke's argument. "Sometimes," he says, the organs "are *called* 'aborted,' sometimes 'degenerated,'" &c. This certainly is so for no less a reason than that sometimes they *are* aborted, while at other times they are "representative," or sometimes, again, they are incipient organs. So variously, indeed, are the organs affected, that Darwin found it in some cases extremely difficult to pronounce respecting them.[1] The uninitiated in the subject would naturally infer, from the letter in question, that Darwin had never devoted any of his pages to the discussion of those organs which he generally spoke of as "nascent"—a term which the Duke, for the purposes of his argument, ignores. There is, moreover, nothing in any way new suggested by him in his communication.

The special case referred to, for instance, is simply one of the difficult problems which Darwin set himself, in the "Origin of Species," to solve, and respecting which he concluded, from his knowledge of all the facts then available, that "as we know nothing about the habits and structure of the progenitors of the existing electric fishes [of the various non-related types dealt with], it would be extremely bold to maintain that no serviceable transitions are possible by which these organs might have been gradually developed" ("Origin," sixth edition, p. 150). Whilst in the "Descent" a long section is devoted to the citation of instances of homologous rudimentary structures in man, and functionless organs generally are amply treated upon elsewhere—compare the various references in "Variation," and also "Origin" (pp. 108–12). In some instances they are determined to be vestigial, though for the most part they can only be so recognized in their ancestral relation.

Although Prof. Ray Lankester, in his interesting chapter on "Degeneration" ("Nature Series"), aptly remarked, "We have as possibilities either *balance*, or *elaboration*, or *degeneration*," I am inclined to think—in agreement, probably, with the Duke—that in that paper perhaps too much weight was attached to the last-named process. Perhaps it was due to the expressed desire of calling attention to Dr. Dohrn's treatise on the subject; but, after all, it is simply a view that is taken respecting certain important facts, and whether an organ in a transitional state is progressing or retrogressing is a matter which relates chiefly to time, and does not invalidate the fact of the change that is in process of evolution. It has not, however, been satisfactorily proved, so far as I can find, that the limited digitation in *Bipes* and *Seps* is the result of atrophy, as decidedly stated by Prof. Lankester; but as I am uninformed respecting the ontogeny—upon which everything depends—of these reptilian forms, I may be wrong in questioning this point.

Instances of transitional and incipient organs, rare though they may be, *have*, therefore, been fully considered by Darwin in his volumes; but we may, speaking more generally, truly say that the entire development hypothesis is a recognition of the structural deformation of nascent organs, which are ever being reconstituted, mainly in a progressive direction. The difficulty of actually observing an organ in process of development was acknowledged by Darwin to be considerable, partly on account of the slow rate of progression, and partly because

[1] "It is often difficult to distinguish between rudimentary and nascent organs; for we can judge only by analogy whether a part is capable of further development, in which case alone it deserves to be called nascent" "Origin," sixth edition, p. 398).

"nascent organs will rarely have been handed down, . . . for beings with any important organ but little developed will generally have been supplanted by their descendants with the organ well developed" ("Life and Letters," vol. ii. p. 214). If, however, the Duke of Argyll is prepared to furnish a chapter upon the evidences of "prophetic germs," with which he appears to be extensively acquainted, he will confer a favour upon the waiting scientific world by publishing it.

With regard to the utility of rudimentary organs, the Duke has perverted entirely the doctrine given by Darwin, who certainly did *not* ascribe "*all* organic structures to utility as a physical cause," while even if that were the case, the doctrine of prophetic germs is in no way opposed to it. In his lengthy letter to Lyell, which probably the Duke has in his mind, Darwin remarks:—"A nascent organ, though little developed, as it has to be developed, must be useful in every stage of development. As we cannot prophesy, we cannot tell what organs are now nascent" ("Life," ii. p. 213). This observation, before it can be properly understood, however, requires to be amplified by reference to the full text from which it was abstracted, in which the following remarks also occur:—"In many cases we are far too ignorant to be enabled to assert that a part or organ is so unimportant for the welfare of a species that modifications in its structure could not have been slowly accumulated by means of natural selection. In many other cases modifications are probably the direct result of the laws of variation, or of growth, *independent of any good* having thus been gained" ("Origin," pp. 165-66). Yet natural selection "will never produce in a being any structure more injurious than beneficial to that being" (p. 162), and Darwin fully held that it does not necessarily lead to "absolute perfection," which, indeed, would almost amount to a denial of the necessity of variation. Furthermore, "useful organs, however little they may be developed, unless we have reason to suppose that they were formerly more highly developed, ought not to be considered as rudimentary. They may be in a nascent condition, and in a progress towards further development. Rudimentary organs, on the other hand, are either quite useless . . . or almost useless; . . . they cannot have been produced through variation and natural selection, which act solely by the preservation of useful modifications. They have been partially retained by the power of inheritance, and relate to a former state of things" (*et seq.*, 'Origin," p. 398).

The above references I have quoted somewhat fully, because they appear to me to present a complete disavowal of the two assertions made by the Duke of Argyll, namely (1) that the physical cause of all organic structures is ascribed to utility; and (2) that functionless organs "are never interpreted as utilities which are yet to be." WILLIAM WHITE.

August 18.

Lamarckism *versus* Darwinism.

MR. POULTON says it is to be regretted that I have not written anything which can be considered as a reply to his previous letter. But this is exactly what I did. In that letter he merely made the bald statement that I had not acquainted myself with the views of Prof. Weismann, which I had "professed to express." This statement I denied, and what further "reply" it admits of I must leave Mr. Poulton to explain.

Regarding his present suggestion, that it would be well for me to justify a remark in the *Contemporary Review*, which he challenged, I can only repeat that I have no desire to continue a correspondence which was opened in the manner alluded to. And, in repeating this plain statement, I am as far as ever from experiencing any of the "annoyance" which he says I have taken no pains to conceal. Unless by annoyance he means surprise, I am at a loss to understand why he should suppose that I entertain any feeling of the kind.

Prof. E. Ray Lankester's views "upon the interesting question of Lamarck *versus* Darwin" are, of course, well known to all biologists; but I think it is somewhat too strong a statement to say that they are "diametrically opposed" to mine. No doubt he has been more influenced by Prof. Weismann's recent theories; but I feel sure he would agree with me that the time has not yet come for the formation of any matured "opinion" upon this subject.

Prof. Meldola is kind enough to express disappointment that I have not given a more explicit statement of my views on the theoretical bearings of Mr. Poulton's experiments. The tone of this invitation induces me to comply with his request. But in order to do so it will be necessary to go at considerable length into the whole question of "Lamarckism *versus* Darwinism." As this has now become a very extensive and somewhat involved question, I cannot feel that the correspondence columns of NATURE afford a suitable place for its discussion. But I will bear the matter in mind, and, as soon as other work shall have been cleared off, will publish an essay upon the whole subject. Mr. Poulton, too, will then find that it is easy enough to "notice the criticism," without requiring "to show that his [my] remark about Prof. Weismann is intended to bear some other than its obvious meaning."

Meanwhile, I should like to represent how undesirable it is to employ phraseology which associates the name of Darwin with the post-Darwinian theories which are in question. Here, for instance, we have a correspondence headed "Lamarckism *versus* Darwinism" where the title ought to be "Darwinism *versus* Weismannism"; and while on the one hand Prof. Meldola speaks of "the recent revival of 'pure' Lamarckism," on the other he alludes to Prof. Weismann's interpretations as those which belong to "the purely Darwinian stand-point." The consequence of this kind of writing is that anyone who, like myself, still retains unmodified the Darwinism of Darwin himself, is ticketed as a follower of Lamarck. Therefore, if only as a matter of historical accuracy, and in order to avoid confusion in non-biological circles, it seems to me that such terms ought to be avoided. Most people will always understand that "Darwinism" is intended to mean the theory of evolution as held by Darwin, yet this is just the very thing that it is not intended to mean by your other correspondents: the more "pure" their "Darwinism," the further does it depart from the doctrine of evolution as presented in the "Origin of Species." As a matter of fact, there has been no "recent revival of 'pure' Lamarckism": there has merely been a question raised as to whether the amount of Lamarckism which was sanctioned by Darwin may not be dispensed with. Now, not only is this question, as already remarked, post-Darwinian in its origin, but the speculations which have given rise to it are ultra-Darwinian in their object: they aim at establishing for natural selection a sole and universal sovereignty which was never claimed for it by Darwin himself. Far be it from me to pre-judge a question which must assuredly involve a large amount of future research; but however this question may eventually be decided, there is no need to confuse the issues by the use of historically inaccurate terms. The school of Weismann may properly be called Neo-Darwinian: pure Darwinian it certainly is not.

GEORGE J. ROMANES.

Geanies, Ross-shire, N.B., August 26.

A Substitute for Carbon Disulphide in Prisms, &c.

IT may be worth mentioning that the highly-refractive liquid, phenyl-thiocarbimide (molecular formula, C_6H_5NCS), to which I drew attention some little time ago at a meeting of the Physical Society (see NATURE, vol. xxxvii. p. 165), can now be obtained as an ordinary article of commerce from Schuchardt, of Görlitz, and Kahlbaum, of Berlin.

I have recently again determined its refractive indices for different rays, but the values (when allowance is made for temperature) do not appreciably differ from my former results, or from those given by Nasini (*Atti R.A. dei Lyncei*, June 20, 1886) for the substance which he calls "iso-solfocianato-fenilico," as Dr. Gladstone has kindly mentioned to me since the meeting. Thus, taking rays near the ends of the visible spectrum, I find (at a temperature of 10° C.)—

Fraunhofer line.	Index of refraction.
B*	1·639
G	1·707

The coefficient of dispersion, calculated from the above values, is 0·068, rather higher than even that of carbon disulphide for the same rays, which is 0·062.

Phenyl-thiocarbimide seems, in fact, to have about the highest refractive and dispersive power of any fairly permanent *colourless* liquid known at present. Carbon disulphide, though colourless when pure, is apt to turn yellow with age and exposure to light, and monobromonaphthalene has an incurably yellow colour (as also has mercury barium iodide), which of course implies an absorptive action on the more refrangible part of the spectrum.

* Not A, as printed in NATURE (*loc. cit.*). The index for A is 1·6312.

Dense glass shows the same defect, besides its great liability to become tarnished.

Another advantage possessed by phenyl-thiocarbimide is its very high boiling-point, viz. 222° C. It is practically non-volatile at ordinary temperatures, and a lighted match may be put into it without setting it on fire. It has, of course, the pungent smell characteristic of all the mustard-oils (to which class it belongs); but this, from the slight volatility of the substance, gives no practical inconvenience.

It dissolves iodine freely, but, from the complexity of its molecule, we cannot expect it to be so diathermic as carbon disulphide. It also readily dissolves metacinnamene (one of the most highly-refractive resinous substances that I have been able to meet with; $\mu_D = 1·6$, nearly), and the viscous solution is useful in determining refractive indices by Wollaston's total reflexion method, or Bertrand's modification of it.

It can be safely used in the ordinary hollow prisms, as it has no action on the mixture of isinglass and sugar with which these prisms are cemented. H. G. MADAN.

Eton College, August 28.

Michell's Problem.

I HAVE read with considerable interest the short letter in NATURE of August 9 (p. 342), in which Mr. Joseph Kleiber refers to a paper of his own on the controversy between Michell and Forbes, and notices what he believes to be a mistake in my paper of July 19 (p. 272). Mr. Kleiber shows that the experiments of Forbes on random distribution by scattering rice over a chess-board, and also some additional experiments of his own on numbers taken successively from a table of logarithms, are in accordance with the ordinary formula for finding the probable number of squares containing r grains, where m is the number of squares and n the total number of grains—

$$mp_r = m\,\underline{|n}\,(1/m)^r(1 - 1/m)^{n-r}/\underline{|r}\,\underline{|n-r}.$$

He concludes that "the theory of probabilities does not affirm that 'a perfectly uniform and symmetrical disposition of stars over the sky would (if possible) be that which could alone afford no evidence of causation or any interference with the laws of random.'"

Forbes, throughout his paper, is not attempting to controvert either the theory of probabilities, of which he himself makes frequent use, or the result arrived at by Michell and Struve, but only Michell's method of applying the theory of probabilities to prove his point. Hence it seems to me that Mr. Kleiber's paper is not so convincing as he takes it to be; one may agree with his experiments, mathematics, and conclusion, without admitting the truth of Michell's argument.

Mr. Kleiber's second objection is, I think, founded on a misconception due possibly to too great regard on my part for the exigencies of your space. As an example of distribution, I suggest a number of stars shot at random from the centre upon the interior surface of a sphere. The idea may be roughly represented by the explosion of a small uniform shell of shot in the centre of a globe lined with clay. I then attempt to prove that the chance of exactly uniform distribution is *nil*, and proceed: "Michell, however, seems to assume this probability to be 1, or certainty." Mr. Kleiber strongly repudiates any such assumption on the part of Michell. It is always, I admit, a little doubtful to attribute to anyone an opinion which is not distinctly stated, but to Forbes, as well as to myself, the assumption seems to be clear. For if the distribution is not uniform, and any groups of stars are formed, Michell's argument applies in its entirety, and he would prove, of course with greater or less probability, *a posteriori* that the arrangement is due to a cause, while *a priori* from the datum of shooting out at random, the distribution is due to chance. SYDNEY LUPTON.

Remarkable Rainbows.

ON Saturday, at 3.15 p.m., there was a very brilliant primary rainbow, and a faint secondary bow above. Inside the primary, at first to the right of the centre, afterwards over the entire centre, were two other very faint bows, their colours in the same order as those of the primary, but with no distinguishable red, the violet of the upper bow seeming to touch the orange of the bow below in each case. Green was the most striking colour in the two inner bows, whose breadth appeared equal to each other, but considerably less than that of the primary; part of this effect being due to the loss of the red, probably all the remainder to irradiation. The perfect primary arch lasted fifteen minutes; an arc of the eastern side half an hour. The sun being comparatively high, the centre of the arch was low, and the bow looked flat. There was no wind, and many of the rain-drops were large, others mere dots.

At 5.5, during a thunder-shower, there was a fairly bright primary with perfect arch, and two faint arcs of a secondary bow, but I saw no trace of inner bows. This primary differed in height and brightness from the other, and the rain was a downpour of heavy drops.

Judging by relative brightness, the inner bows should seldom be seen. L. J. H.

Rock Ferry, August 27.

I HAVE been unable to send sooner the following, which you may perhaps think worth inserting in NATURE.

On the 18th of July, at 7.30 p.m., I saw a most remarkable rainbow. A sudden light fell on the book I was reading, so powerful that I thought it must be some neighbouring house on fire. It was a rainbow coming across the mountains opposite (Savoie), and ending in the lake just at the "Bec de Peilz," which some of your readers will know. It was only a section of the rainbow, and was not continued in any other part of the sky, and it was so small a section that it scarcely appeared bent, but looked like a fiery column coloured as a rainbow, but having the peculiarity of *not showing the mountain through it*: it cut it sheer off, and yet the mountain was looking unusually dark, and indeed the brilliancy of the sunset was such that all came out in strong relief. The sky was covered with stormy clouds with breaks of brightness, and above this column they hung in golden radiance such as only painting could faintly convey an idea of. Certainly I never saw so beautiful or curious a sight. It lasted about six minutes. M. C. C.

La Tour de Peilz, August 17.

Sun Columns.

I HAVE never before seen the phenomenon of sun columns in such splendour as on the 11th inst. The day was very hot, the wind a pretty stiff westerly one, and the sky perfectly cloudless. After sunset, which (according to the calendar) took place at 7h. 27m. p.m., several sun columns became visible. They were seen to grow in length, and at 7h. 40m. they extended over the whole sky. The columns were five in number, and pretty regularly distributed, so that one passed through the zenith, two on the north, and two on the south of it at equal distances. A very small cloud was visible at that time in the west-north-west. The colour of the shades was dark blue, and their width in the zenith from 2° to 4°. The lighted parts of the sky had a pale violet colour. The rays extended over the whole sky like meridians on a globe, and all five columns were seen to meet in one point in the east-south-east, about 5° above the horizon. The phenomenon could be seen well in all its extension, as I watched it from a hill 688 metres above the sea-level. The intensity of the colour of the columns was at its highest at 7h. 45m. (Prague local time), and it disappeared at 7h. 50m.

I hope, Sir, that you will be able to mention this not very common phenomenon in the columns of NATURE.

St. Benigna, Bohemia, August 14. B. BRAUNER.

Meteor.

THE most brilliant meteor I have ever seen flashed across the sky here from east to west, about 7.10 p.m. on the 30th ult. I was riding along a dark road, looking downwards, when suddenly the road was so brightly lit up that I thought the lamp-lighter had lit another lamp. Seeing neither lamp nor lamp-lighter, I looked up, just in time to catch a glimpse of the meteor. It was of an intense white colour, with a train or track of white behind it. When about 45° above the horizon, it appeared to burst like a sky-rocket, but not so violently. It lasted about two seconds. H. W. L. HIME.

Coonoor, Madras, August 1.

P.S.—August 2. Since writing my letter of yesterday I am informed by Lieut. M. de Montmorency, Hampshire Regiment, that the meteor I mentioned burst *with a loud noise*. I can only suppose that the noise of my horse's hoofs prevented me from hearing it.—H. W. L. H.

Fire-ball of August 13—August Meteors.

A COMPARISON of several good observations of this brilliant visitor shows that the point of its first appearance was over a place near Masham, in Yorkshire, at a height of 79 miles. The disappearance occurred over Gisburn, in the same county, after the meteor had traversed a course of about 48 miles, and when it had descended to within 47 miles of the earth's surface. It was directed to a point covered by the River Mersey a few miles west of Liverpool.

By a clerical error the figures representing the real paths of three of the seven doubly-observed meteors seen on August 5 and 8 last (NATURE, August 23, p. 395) were incorrectly stated. The lengths of Nos. 1, 3, and 7 in the list should be 41, 41, and 36 miles respectively.

Including the fire-ball mentioned above, the mean length of path of eight meteors seen during the present month was 37 miles. Seven of these bodies were Perseids, with an average radiant at $46° + 57°$, which nearly corresponds with the best determinations for the emanating centre of this shower.

W. F. DENNING.

Bristol, August 25.

Sonorous Sand in Dorsetshire.

IT may be interesting to know that I have discovered the existence of "musical" sand on the sea-beach at a spot between Studland Bay and Poole Harbour.

This sand, though not emitting sounds quite so loud as those produced in the Eigg sand, answers all the usual tests, and gives out a distinct note when walked upon or when agitated by the hand or a stick.

Briefly, I may state that I have been investigating the phenomenon for the last two years, and that an examination of this Dorsetshire sand gives fresh evidence in support of my theory (shortly to be published) as to the cause of the sounds. I may add that I had reasons for thinking that the sand on this particular beach *ought* to be sonorous under certain favourable conditions, but that I had visited it before without success.

It is now over thirty years since Hugh Miller discovered this sand at Eigg, and up to the present instance I am not aware that it has again been found in any other part of Europe.

CECIL CARUS-WILSON.

Bournemouth, August 18.

A Column of Dust.

THE following account of a somewhat unusual phenomenon may not be uninteresting to some of your readers. As Mr. Emil Trechmann, lecturer at Bangor University, and myself were walking in the vicinity of Stockton-on-Tees on Sunday last, about half-past one o'clock, we observed a small column of dust to rise suddenly on the road about 40 or 50 yards in front of us. There was not a breath of wind stirring at the time, yet it was evidently raised by the action of what would popularly be called a small whirlwind. This column of dust moved quickly across the road, ceasing when it reached the other side; and had the incident terminated there, we should doubtless have exhibited a passing surprise and have forgotten about it. Fortunately, however, there was a hay-field on the other side of the road, and we presently saw several large wisps of hay lifted off the tops of some haycocks, to the amount of perhaps a small-sized armful, and carried across the fields for a distance of a quarter of a mile or more, at the height of 40 or 50 feet.

Trivial as the incident may seem, it was to us singularly startling and impressive, and it was easy to imagine how, in a superstitious age, such phenomena would be attributed to supernatural agency. The mind instantly recurred to stories of witches transporting haystacks through the air, and it was difficult not to believe that, with increased force of current almost anything might have been carried aloft in a similar way.

The atmosphere remained perfectly undisturbed for at least five minutes after the occurrence, when a single "sough" of wind passed by, and it then resumed its former stillness. The general aspect of the weather was somewhat thunderous, though it remained fine until night.

HUGH TAYLOR.

20 Fraser Terrace, Gateshead-on-Tyne, August 22.

THE INTERNATIONAL GEOLOGICAL CONGRESS.

EXACTLY ten years have passed since the International Geological Congress held its first meeting It was on the 29th of August, 1878, that the Congress was inaugurated at the Palace of the Trocadéro in Paris; this meeting having been the direct result of a suggestion made by the American Association for the Advancement of Science at Buffalo, on the close of the Philadelphia Exhibition of 1876. A Committee was then formed, with Prof. James Hall, of Albany, as President, and Dr. Sterry Hunt as Secretary, for the purpose of organizing an International Congress of Geologists to be held in Paris during the Universal Exhibition in 1878. The prime object of the Congress was to discuss, and if possible settle, questions of geological classification and nomenclature, and to formulate rules for securing uniformity in geological cartography. The original American Committee—*Comité fondateur*—applied in due course to the Geological Society of France for assistance in carrying their suggestions into effect, and an influential organizing Committee was formed in Paris, under the presidency of Prof. Hébert. By the action of this Committee the arrangements were carried to a successful issue. The Paris Congress numbered 304 members; it appointed Committees for the unification of stratigraphical and palæontological nomenclature, and for systematizing the colours and signs on geological maps. Ultimately its proceedings were published in a *Compte rendu* of 313 pages.

After an interval of three years, the Congress held its second session. This was in Bologna, under Prof. Capellini as President. One of the chief results of this meeting was the nomination of a Committee for the purpose of preparing an International Geological Map of Europe, on a scale of 1 to 1,500,000. On this Committee, as at present constituted, Germany is represented by Prof. Beyrich and M. Hauchecorne, France by M. Daubrée, Great Britain by Mr. Topley, Austria-Hungary by M. Mojsisovics, Italy by M. Giordano, Russia by M. Karpinsky, and Switzerland by Prof. Renevier. The Report of the Bologna meeting was issued as a handsome volume of 660 pages.[1]

As the meetings of the Congress are triennial, the next gathering was due in 1884, but an outbreak of cholera on the Continent rendered it advisable to postpone the session for another year. It was therefore in 1885 that the Congress assembled for the third time—Berlin being the place of meeting, and Prof. E. Beyrich the President. The meeting was eminently successful, but it is to be regretted that no official volume, containing a full report of the proceedings, has yet been published.

Three years have again passed, and the Congress is about to hold its fourth session. London has been selected as the meeting-place, and by permission of the Senate of the University of London the sittings will be held in the University buildings in Burlington Gardens. The first general assembly of the Congress will take place in the theatre of the University at 8 o'clock on Monday evening, September 17, when the inaugural address will be delivered in French by Prof. Prestwich, as President. French is the official language of the Congress, but considerable latitude is allowed in the discussions, and much English and German will probably be spoken at the forthcoming meetings.

On Tuesday morning the Congress will meet at 10 o'clock, for the purpose of discussing questions bearing upon geological nomenclature and classification. A full and valuable Report on these subjects will be presented by the American Committee. This Report, which has been printed in advance, forms a volume of 220 pages, edited by Prof. Persifor Frazer. Although written

[1] For report of the Bologna Congress see NATURE, vol. xxv. p. 34.

in English, a French abstract has been prepared by Prof. Dewalque, the Secretary of the General Committee on Unification of Nomenclature; and copies of this abstract will be distributed at the meeting. The English Committee, under the presidency of Prof. T. McK. Hughes, will also present its revised Report, which is now being printed, and forms a substantial work.

Opportunity will be given on Tuesday afternoon for visiting the British Museum, where the fine collections illustrative of prehistoric archæology will be examined under the guidance of Mr. A. W. Franks.

On Wednesday morning the sitting will be occupied with the discussion of a subject which has of late years been warmly debated in geological circles—the nature and origin of the crystalline schists. Special authorities on this subject have been invited to contribute short memoirs which have been printed in advance. As copies of these papers will be distributed to the members, the communications may be taken as read and the time of the meeting occupied only in their discussion. The volumes of papers entitled "Études sur les Schistes Crystallins," contains the following communications:—"Les Schistes Cristallins," by Dr. Sterry Hunt; "Zur Klassification der krystallinischen Schiefer," by Prof. A. Heim, of Zürich; "Sur la Constitution et la Structure des Massifs de Schistes Cristallins des Alpes Occidentales," by Prof. C. Lory, of Grenoble; "Bemerkungen zu einigen neueren Arbeiten über krystallinisch-schiefrige Gesteine," by Prof. J. Lehmann, of Kiel; "Sur l'Origine des Terrains Cristallins Primitifs," by M. Michel-Lévy, of Paris; "The Archæan Geology of the Region North-West of Lake Superior," by A. C. Lawson, of the Geological Survey of Canada; "On the Crystalline Schists of the United States and their Relations," by various members of the United States Geological Survey; and a paper by M. K. A. Lossen, of the Geological Survey of Prussia. The group of papers contributed by the United States Survey contains first an "Introduction," by Major J. W. Powell, the Director, followed by a paper on "The Crystalline Schists of the Lake Superior District," by the late R. D. Irving, and T. Chamberlin and C. R. Van Hise; this is succeeded by a sketch of "The Crystalline Schists of the Coast Ranges of California," by G. F. Becker, and a brief description of "The Crystalline Rocks of Northern California and Southern Oregon," by Captain C. E. Dutton.

Wednesday afternoon will be devoted to a visit to the Natural History Department of the British Museum where the visitors will be received by Prof. Flower, as Director of the establishment.

On Wednesday evening the Congress will be received by Dr. A. Geikie, as Director-General of the Geological Survey, at the Museum of Practical Geology in Jermyn Street. With the view of illustrating the subjects that will have been discussed at the morning sitting, it is proposed that during the evening a series of microscopic sections showing the structure of the crystalline schists shall be exhibited on the screen, by means of the lime-light, in the theatre of the Museum.

At 10 o'clock on Thursday morning the Congress will re-assemble in the University theatre, and proceed to the discussion of questions bearing upon the International Map of Europe. The Map Committee will present its Report, and exhibit specimen sheets illustrating the character of the work. In the afternoon the members will make excursions in various directions. One party will visit Windsor and Eton, where they will be entertained by the masters of Eton College; another party will visit Kew, and be received by Mr. Thiselton Dyer, as Director of the Royal Gardens; other members will go down the river to Erith and Crayford for the purpose of examining the brick-earths and gravels of the Thames valley; while others will probably visit Watford and St. Albans.

At the meeting on Friday morning the discussion on nomenclature and classification, and on the coloration of maps, will be resumed. In the evening there will be a reception at the rooms of the Geological Society at Burlington House, by Dr. W. T. Blanford, as President of the Society. An evening reception, the date of which is not yet fixed, will also be held by Prof. Prestwich, the President of the Congress. The concluding business of the Congress, mostly of a formal character, will be taken at Saturday morning's sitting.

By permission of the Council of the Zoological Society, the Society's Gardens in Regent's Park will be open free to members of the Congress, not only during the week of the meetings but (after 1 o'clock) on Sundays, September 16 and 23.

Several geological excursions have been organized for the week following the London session. One of these, which promises to be extremely popular, is to the Isle of Wight, under the direction of Messrs. W. Whitaker, J. Starkie Gardner, A. Strahan, and H. Keeping. By invitation of Sir Charles Wilson, this party will also visit the offices of the Ordnance Survey at Southampton. Another interesting excursion is to North Wales under Dr. H. Hicks, assisted by Prof. J. H. Blake for Anglesey, and by Mr. G. H. Morton for the Carboniferous Limestone of Llangollen. A third excursion is planned to East Yorkshire, under the direction of Mr. J. W. Woodall and Mr. C. Fox-Strangways, assisted by Mr. W. H. Hudleston, for some of the Oolitic series. Mr. G. H. Lamplugh for the Flamborough Chalk, and Mr. Hugh Bell, for the mines and iron-works of Middlesborough. West Yorkshire will also be visited by a party under the guidance of Mr. J. E. Marr and Mr. R. H. Tiddeman. Finally, an excursion to East Anglia has been organized under Mr. F. W. Harmer (Mayor of Norwich) and Mr. Clement Reid, assisted for the older Pliocene beds of Suffolk by Dr. J. E. Taylor, of the Ipswich Museum. A guide-book containing geological descriptions of the localities about to be visited, written in French and illustrated by coloured geological maps, is in course of preparation, and will be presented to the members of the Congress. To this guide-book Mr. Topley has contributed a sketch of the geology of the various railway routes by which foreigners will reach London.

The great interest taken in the forthcoming meeting is attested by the fact that already between 500 and 600 members have been registered. The list includes nearly all the most distinguished geologists on the Continent and in America, many of whom will arrive in time to be present at the Bath meeting of the British Association during the week preceding the opening of the Congress. It is known that many of these geologists will bring with them collections of minerals, rocks, and fossils, for exhibition in the temporary Museum which will be formed in the library of the University of London, and which promises to be one of the most interesting features of the meeting. On the whole, there can be no question that the success of the forthcoming session of the Congress is abundantly assured.

MODERN VIEWS OF ELECTRICITY.[1]

PART IV.—RADIATION.

X.

HAVING now described a possible method of measuring the velocity of electric wave propagation, and therefore of at least the ratio of the two ethereal constants k and μ, by an experiment on the different parts of one enormously large and properly chosen circuit: return to the consideration of the ordinary small discharging Leyden jar or other alternating current circuit of a moderate size, it may be a few yards or a foot or an inch in diameter.

If the alternating currents are produced artificially by

[1] Continued from p. 393.

some form of alternating machine, their frequency is, of course, arbitrary; but if they be automatically caused by the recoil of a given Leyden jar in a given circuit, their frequency is, as we have already said,

$$\frac{1}{2\pi\sqrt{(LS)}} \text{ per second};$$

where L is the electrical inertia or self-induction of the circuit, and where S is the capacity or reciprocal of the elasticity constant of the jar.

It is not convenient here to go into the determination of the quantity L, but roughly one may say that for an ordinary open single-loop circuit it is a quantity somewhat comparable with twelve or fifteen times its circumference multiplied by the constant μ.

The value of S has to do with the area and thickness of the condenser, being, as is well known, $\frac{A}{4\pi z}$ multiplied by the constant K.

The product LS contains therefore two factors, each of linear dimensions, expressing the sizes of circuit and jar, and likewise contains a factor μK expressing the properties of the surrounding medium. Hence, so far as the ether is concerned, the above expression for frequency of vibration demands only a knowledge of the *product* of its two constants K and μ, and since this is known by the previous velocity experiment, it is easy to calculate the rate of oscillation of any given condenser discharge. It is also easy to calculate the wave-length; for if there are n waves produced per second, and each travels with the velocity v, the length of each wave is $\frac{v}{n}$.

Hence the wave-length is $2\pi\sqrt{\left(\frac{L}{\mu}\cdot\frac{S}{K}\right)}$.

Now, if we go through these numerical calculations for an ordinary Leyden jar and discharger, we shall find waves something like, say, 50 or 100 yards long. They may plainly be of any length, according to the size of the jar and the size of the circuit. The bigger both these are the longer will be the waves.

A condenser of 1 microfarad capacity, discharging through a coil of self-induction 1 secohm, will give rise to ether waves 1900 kilometres or 1200 miles long.

A common pint Leyden jar discharging through a pair of tongs may start a system of ether waves each not longer than about 15 or 20 metres.

A tiny thimble-sized jar overflowing its edge may propagate waves only about 2 or 3 feet long.

The oscillations of current thus recognized as setting up waves have only a small duration, unless there is some means of maintaining them. How long they will last depends upon the conductivity of the circuit; but even in a circuit of infinite conductivity they must die out if left to themselves, from the mere fact that they dissipate their energy by radiation. One may get 100 or 1000, or perhaps even 100,000, perceptible oscillations of gradually decreasing amplitude, but the rate of oscillation is so great that their whole duration may still be an extremely small fraction of a second. For instance, to produce ether waves a metre in length requires 300,000,000 oscillations per second.

To keep up continuous radiation naturally requires a supply of energy, and unless it is so supplied the radiation rapidly ceases. Commercial alternating machines are artificial and cumbrous contrivances for maintaining electrical vibrations in circuits of finite resistance, and in despite of loss by radiation.

In most commercial circuits the loss by radiation is probably so small a fraction of the whole dissipation of energy as to be practically negligible; but one is, of course, not limited to the consideration of commercial circuits or to alternating machines as at present invented and used. It may be possible to devise some less direct method—some chemical method, perhaps—for supplying energy to an oscillating circuit, and so converting what would be a mere discharge or flash into a continuous source of radiation.

So far we have only considered ordinary practicable electrical circuits, and have found their waves in all cases pretty long, but getting distinctly shorter the smaller we take the circuit. Continue the process of reduction in size further, and ask what sized circuit will give waves 6000 tenth-metres (three-fifths of a *micron*, or 25 millionths of an inch) long. We have only to put $2\pi\sqrt{\left(\frac{L}{\mu}\cdot\frac{S}{K}\right)} =$ 0·00006, and we find that the necessary circuit must have a self-induction in electro-magnetic units, and a capacity in electrostatic units, such that their geometric mean is 10^{-5} centimetre (one-tenth of a micron). This gives us at once something of atomic dimensions for the circuit, and suggests immediately that those short ethereal waves which are able to affect the retina, and which we are accustomed to call "light," may be really excited by electrical oscillations or surgings in circuits of atomic dimensions.

If after the vibrations are once excited there is no source of energy competent to maintain them, the light production will soon cease, and we shall have merely the temporary phenomenon of phosphorescence; but if there is an available supply of suitable energy, the electrical vibrations may continue, and the radiation may become no longer an evanescent brightness, but a steady and permanent glow.

Velocity of Electrical Radiation compared with Velocity of Light.

We have thus imagined the now well-known Maxwellian theory of light, viz. that it is produced by electrical vibrations, and that its waves are electrical waves.

But what justification is there for such an hypothesis beyond the mere fact which we have here insisted on, viz. that waves in all respects like light-waves except size, *i.e.* transverse vibrations travelling at a certain pace through ether, can certainly be produced temporarily in practicable circuits by familiar and very simple means, and *could* be produced of exactly the length proper to any given kind of light if only it were feasible to deal with circuits ultra-microscopic in size? The simplest point to consider is: Does light travel at the same speed as the electrical disturbances we have been considering? We described one method of measuring how fast electrical radiation travels in free space, and there are many other methods: the result was 300,000 kilometres per second.

Methods of measuring the velocity of light have long been known, and the result of those measurements in free space or air is likewise 300,000 kilometres a second. The two velocities agree in free space. Hence surely light and electrical radiation are identical.

But there is a further test. The speed of electrical radiation was not the same in all media: it depended on the electrical elasticity and the ethereal density of the transparent substance; in other words, it was equal to the reciprocal of the geometric mean of its specific inductive capacity and its magnetic permeability—

$$v = \frac{1}{\sqrt{(K\mu)}}.$$

Now, although the absolute value of neither K nor μ is known, yet their values relatively to air are often measured and are known for most substances.

Also, it is easy to compare the pace at which light goes through any substance with its velocity in free space: the operation is called finding the refractive index of a substance. The refractive index means, in fact, simply the ratio of the velocity of light in space to its velocity in the given substance. The reciprocal of the index of refraction is therefore the relative velocity of light. Calling the index of refraction n, therefore, we ought, if the

electrical theory of light be true, to find that $n^2 = K\mu$; or that the index of refraction of any substance is the geometric mean of its electrostatic and magnetic specific capacities.

That this is precisely true for all substances cannot at present be asserted. There are some substances for which it is very satisfactorily true: there are others which are apparent exceptions. It remains to examine whether they are not only apparent but real exceptions, and, if so, to what their exceptional behaviour is due.

It must be understood what the essential point is. It has been proved by various methods, and with greater approach to exactness as the accuracy of the methods is improved, that electrical disturbances—such as the long waves emitted by any alternating machine—travel through air or free space with exactly the same velocity as light; in other words, that there is no recognizable difference in speed between waves several hundred miles long and waves so small that a hundred thousand of them can lie in an inch. This is true in free ether, and it is a remarkable fact. If it proves anything concerning the structure of the ether, it proves that it is continuous, homogeneous, and simple beyond any other substance; or at least that if it does possess any structural heterogeneity, the parts of which it is composed are so nearly infinitesimal that a hundred miles and the hundred-thousandth of an inch are quantities of practically the same order of magnitude so far as they are concerned: its parts are able to treat all this variety of wave-length in the same manner.

But directly one gets to deal with ordinary gross matter we know that this is certainly not the case. Ordinary matter is composed of molecules which, though small, are far from being infinitesimal. Atoms are much smaller than light-waves, indeed, but not incomparably smaller. Hence it is natural to suppose that the ether as modified by matter will be modified in a similarly heterogeneous manner; and will accordingly not be able to treat waves of all sizes in the same way.

The speed of all waves is retarded by entering gross matter, but we should expect the smallest waves to be retarded most. The phenomenon is well marked even within the range of such light-waves as can affect the retina: the smaller waves—those which produce the sensation of blue—are more retarded, and travel a little slower, through, say, glass or water, than the somewhat larger ones which produce the sensation of red. This phenomenon has long been known, and is called dispersion. Hence it is not easy to say at what rate waves a few inches or a few yards or miles long ought to travel, by merely knowing at what rate the ultra-microscopic light-waves travel.

But there is even more to be said than this. There is not only dispersion, there is selective absorption possessed by matter: not only does it transmit different-sized waves at different rates, but it absorbs and quenches some much faster than others. Few substances, perhaps none, are equally transparent to all sizes of waves. Glass, for instance, which transmits readily the assortment of waves able to affect the retina, is practically quite opaque to waves a few hundred times longer or shorter. And whenever this selective absorption occurs, the laws of dispersion are extraordinary—so extraordinary that the dispersion is often spoken of as "anomalous"; which of course means, not that it is lawless, but that its laws are unknown. Dispersion in any case is an obscure and little understood subject, but dispersion modified by selective absorption is still worse. Until the theory of dispersion is better understood, no one is able to say at what speed waves of any given length ought to travel. One can only examine experimentally at what rate they *do* travel. This has been done for long electrical waves, and it has been done for short light-waves: in the case of some substances the speed is the same, in the case of others it is different. But that the speed should be different is, as I have now explained, very natural, and can by no means be twisted into an admission that light-waves and electrical waves are not essentially identical. That the speed of both should agree at all is noteworthy; the agreement appears to be exact in air, and practically exact in such simple substances as sulphur, and in the class of hydrocarbons known as paraffins; whereas in artificial substances like glass, and in organic substances like fats and oils, the agreement is less perfect.

So much for the vital question of the speed at which electrical and optical disturbances travel. In some cases the speeds are accurately the same, in no case are they entirely different; and in those cases where the agreement is only rough, an efficient and satisfactory explanation of the difference is to hand in the very different lengths of wave which have at present been submitted to experiment. To compare the speeds properly, we must either learn to shorten electrical waves, or to lengthen light-waves, or both, and then compare the two things together when of the same size.

It cannot be seriously doubted that they will turn out identical.

Manufacture of Light.

The conclusions at which we have arrived, that light is an electrical disturbance, and that light-waves are excited by electric oscillations, must ultimately, and may shortly, have a practical import.

Our present systems of making light artificially are wasteful and ineffective. We want a certain range of oscillation, between 7000 and 4000 billion vibrations per second: no other is useful to us, because no other has any effect on our retina; but we do not know how to produce vibrations of this rate. We can produce a definite vibration of one or two hundred or thousand per second, in other words, we can excite a pure tone of definite pitch; and we can command any desired range of such tones continuously by means of bellows and a keyboard. We can also (though the fact is less well known) excite momentarily definite ethereal vibrations of some million per second, as I have at length explained; but we do not at present seem to know how to maintain this rate quite continuously. To get much faster rates of vibration than this we have to fall back upon atoms. We know how to make atoms vibrate: it is done by what we call "heating" the substance, and if we could deal with individual atoms unhampered by others, it is possible that we might get a pure and simple mode of vibration from them. It is possible, but unlikely; for atoms, even when isolated, have a multitude of modes of vibration special to themselves, of which only a few are of practical use to us, and we do not know how to excite some without also the others. However, we do not at present even deal with individual atoms; we treat them crowded together in a compact mass, so that their modes of vibration are really infinite.

We take a lump of matter, say a carbon filament or a piece of quick-lime, and by raising its temperature we impress upon its atoms higher and higher modes of vibration, not transmuting the lower into the higher but superposing the higher upon the lower, until at length we get such rates of vibration as our retina is constructed for, and we are satisfied. But how wasteful and indirect and empirical is the process. We want a small range of rapid vibrations, and we know no better than to make the whole series leading up to them. It is as though, in order to sound some little shrill octave of pipes in an organ, we were obliged to depress every key and every pedal, and to blow a young hurricane.

I have purposely selected as examples the more perfect methods of obtaining artificial light, wherein the waste radiation is only useless, and not noxious. But the old-fashioned plan was cruder even than this, it consisted

simply in setting something burning: whereby not only the fuel but the air was consumed, whereby also a most powerful radiation was produced, in the waste waves of which we were content to sit stewing, for the sake of the minute, almost infinitesimal, fraction of it which enabled us to see.

Everyone knows now, however, that combustion is not a pleasant or healthy mode of obtaining light; but everybody does not realize that neither is incandescence a satisfactory and unwasteful method which is likely to be practised for more than a few decades, or perhaps a century.

Look at the furnaces and boilers of a great steam-engine driving a group of dynamos, and estimate the energy expended; and then look at the incandescent filaments of the lamps excited by them, and estimate how much of their radiated energy is of real service to the eye. It will be as the energy of a pitch-pipe to an entire orchestra.

It is not too much to say that a boy turning a handle could, if his energy were properly directed, produce quite as much real light as is produced by all this mass of mechanism and consumption of material.

There might, perhaps, be something contrary to the laws of Nature in thus hoping to get and utilize some specific kind of radiation without the rest, but Lord Rayleigh has shown in a short communication to the British Association at York [1] that it is not so, and that therefore we have a right to try to do it.

We do not yet know how, it is true, but it is one of the things we have got to learn.

Anyone looking at a common glow-worm must be struck with the fact that not by ordinary combustion, nor yet on the steam-engine and dynamo principle, is that easy light produced. Very little waste radiation is there from phosphorescent things in general. Light of the kind able to affect the retina is directly emitted, and for this, for even a large supply of this, a modicum of energy suffices.

Solar radiation consists of waves of all sizes, it is true; but then solar radiation has innumerable things to do besides making things visible. The whole of its energy is useful. In artificial lighting nothing but light is desired; when heat is wanted it is best obtained separately, by combustion. And so soon as we clearly recognize that light is an electrical vibration, so soon shall we begin to beat about for some mode of exciting and maintaining an electrical vibration of any required degree of rapidity. When this has been accomplished, the problem of artificial lighting will have been solved. OLIVER J. LODGE.

(*To be continued.*)

[1] B.A. Report, 1881, p. 526.

STORM WARNINGS.

TWENTY-EIGHT years ago, M. Le Verrier wrote to the Astronomer-Royal at Greenwich inviting the co-operation of this country in his scheme for giving warning of storms by announcing them and following their course by telegraph as soon as they appear at any point of Europe, and in the following year (1861) Admiral FitzRoy established his system, giving notice of storms before they actually strike our coast. Notwithstanding the success which has attended these efforts, storms sometimes overtake us before warning of their approach can be given, and every endeavour to increase our foreknowledge of their movements should be gladly welcomed. Since the year 1860 much additional light has been thrown upon the subject by the systematic publication of synchronous charts, such as those commenced by the late Captain Hoffmeyer, Director of the Danish Meteorological Institute. Several attempts have also been made to utilize the Atlantic cables with the object of giving warning of storms leaving the American coast or met with by the fast steamers bound to the United States; but these efforts have hitherto met with little success from want of sufficient knowledge of the conditions existing over the Atlantic, many storms passing wide of the British Isles, others originating in mid-ocean or dying out there. Of the endeavours to connect our knowledge of the weather over the Atlantic with the reports received from the two shores, the labours of Captain Hoffmeyer as explained in "Études sur les Tempêtes de l'Atlantique septentrional" (Copenhagen, 1880), and recent publications of M. Léon Teisserenc de Bort in the *Annales* of the Central Meteorological Office of France, deserve especial attention. With the view of utilizing the American weather reports for the purpose of improving European weather predictions, M. de Bort has made an investigation of the mean positions of high and low pressures in the northern hemisphere for all winters since 1838, and he shows how these great centres of atmospheric action correspond to different types of weather, that during each season these centres are limited in number, and that each of them when displaced still lies within a definite area.

During the winter season, for instance, the maxima are arranged as follows:—(1) The maximum of Asia, which generally includes two parts, one being near Irkutsk, the other either in Siberia or Russia, one of the positions being usually to the south-west of Tobolsk. (2) The maximum of Madeira, which is also sometimes split up into two parts, one being over the ocean and the other over Switzerland and Central Europe, or joining with a part of the high pressures of Asia. (3) The Bermuda maximum, which is often found over the east of the United States or even in the neighbourhood of Nova Scotia. (4) The continental maximum of America, which usually lies over the mountainous parts. (5) The Polar maximum, which appears over Greenland, Iceland, or Norway. With respect to the minima, there are (1) the low pressure situated over the north of the Atlantic, which may be called the Iceland minimum; (2) a minimum which is mostly to be found in America, generally over the region of the Great Lakes; and (3) a minimum which appears to belong to the Arctic Ocean, and whose centre generally lies near Nova Zembla. These mean positions are laid down in recent barometrical charts, such as those of the Meteorological Office and other institutions. The maxima and minima may combine respectively, but there are scarcely any conditions where at least three centres of high pressure and two centres of low pressure are not to be found between China and California, and between the equator and 80° N. latitude. When the positions of the high and low pressures are well known, we may proceed like the naturalist, and discover, by the examination of some portions, those that are wanting to the whole. The introduction of this method into meteorology has a direct application in the prediction of weather. The telegraphic reports now received allow of the construction on one hand of the isobaric chart over Europe (which ought to be extended as far as Asia), and the isobars in their general features over the United States; between the two there remains the great unknown of the Atlantic. Now by a methodical discussion of the isobars of the two shores of the ocean we ought to be able to reconstitute the conditions over the Atlantic with a great amount of probability. But how are we to know that there are not two or three centres of depression over the ocean, for the number of depressions is not limited? Evidently this is very difficult; but for the object in view—viz. to reconstruct the general features of the isobars with sufficient accuracy to make use of the data for forecasting the weather in Europe—the difficulty is not so great. In fact, either the depressions are grouped so as to be only the subsidiary disturbances of a great minimum, and in this case the position of the minimum may be indicated, which is the important point, or they are completely separated, forming distinct systems of low pressure, and then the trace of them is found in the isobars on the coasts, and often even in the

arrangement or the number of the maxima situated over the Continent.

The essential condition for successfully constructing the isobars is a knowledge of the various types that present themselves, so that we may discover by a simple inspection of the charts of Europe and America what general type is in question. We will give two examples in which M. de Bost shows that the reconstruction of the general chart according to this method would have enabled him to foretell two important storms.

On December 2, 1886, the general conditions were as shown in Chart No. 1.

"By confining our attention to the indications given solely by the chart of Europe," he writes, "we might expect in France cold weather with cloudy sky and sleet showers. On the 4th, a depression which was foretold on the 3rd had spread over the British Isles, where it brought bad weather; but the barometer rose rapidly over the west of Europe. Supposing that the high pressures would extend over Central Europe, we might expect a spell of fine and cold weather. Instead of that a rapid fall of the barometer occurred over the north of Europe, and the wind shifted to south-west. On the 7th and 8th this condition was intensified, and one of the most violent storms that we have experienced for a long time struck us, the barometer at Mullaghmore falling to 27·45 inches."

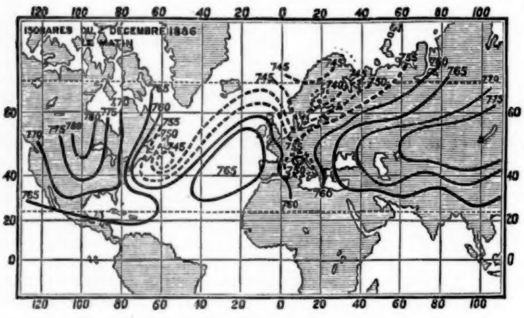

Chart No. 1.—762 mm. = 30·0 inches.

If we refer to the general charts, and particularly to the chart of December 2, we shall see that the barometric maximum of Asia is in its place, and that over the United States there is a large area of high pressure. This is rather extended, and leaves no room for the low pressure of the region of the Lakes except in the vicinity of Newfoundland. As there is also a rather important barometrical maximum to the west of Europe, we conclude that very important low pressures must exist over the ocean off the American coast. Under these conditions, in order to have fine weather, it is necessary that the area of low pressure of Central Europe should shift towards Siberia, so as to allow the maximum to advance over our regions. On the 5th, the increase of the high pressure of Asia towards St. Petersburg and Finland clearly indicates that the area of low pressure cannot shift in its entirety towards the East. The rise of the barometer over the west of Europe must not therefore be taken as a sign of lasting fine weather, but as the result of the approach of the low pressure from the ocean. From these conditions M. de Bort shows that the forecast to be drawn for Western Europe was entirely opposite to that which resulted from the study of the conditions over Europe alone.

Another example of the utility of the construction of the charts over the ocean is afforded by the very sudden change of weather that occurred on the 8th of October, 1887 (Chart No. 2).

The European weather charts indicate at the beginning of the month the existence of an area of high pressure over the west of Europe, and it appears to extend to some distance over the ocean; low pressures are observed over the north of the Continent. This condition persists, with rather cold weather, and on the 7th, in France, a continuation of dry weather is foretold. In England, the forecast bears principally on the consequences of the movement of a small barometric minimum which exists over Scotland.

On the 8th a complete change of system occurred; an important depression reached Europe over Portugal, and the low pressure extended over the north of the British Isles. This depression did not fail to bring a storm from the north-east. While the situation in Europe was considered as fairly stable, and the low pressures of the north of Europe were considered to be chiefly in operation, an important minimum which was advancing from the central part of the ocean suddenly appeared, and produced a complete change of conditions. And yet the predictions of the European meteorologists were certainly the only ones that could have been made from the study of the various daily weather reports. But if we construct the chart of the 5th of October, we shall recognize that a centre of low pressure was very close to the south-west of Spain, and was directly threatening Europe. A mere glance at the Chart No. 2 would have been sufficient to

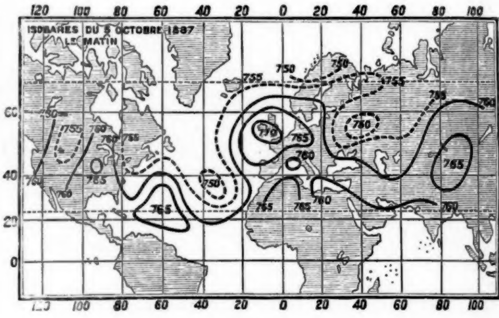

Chart No. 2.

change entirely the weather forecasts in Western Europe, and would have given ample warning of the approach of the storm of the 8th.

As to the reasons which would allow us to trace the isobars over the Atlantic in the way they are represented on the chart; the importance of the barometric maximum situated over the British Isles and the west of Europe is such that we must infer from it that the normal maximum of Madeira was displaced. This conclusion was confirmed by the observations from Madeira, where the barometer was below 29·9 inches, with a south-east wind. Secondly, there were no important low pressures in America, therefore these must exist over the ocean and near Europe, as the observations from Nova Scotia show higher pressures than those from Canada. Everything concurs, therefore, in indicating with certainty the presence of a large barometric minimum over the centre of the ocean, and the importance of this indication for the prediction of the weather in Europe cannot be contested.

From these examples M. de Bort concludes—(1) that, with the aid of telegraphic reports from America, and the knowledge of what is taking place over Europe and Siberia, we can trace the isobars over the ocean with much chance of success; (2) this trace being made, we may take useful advantage of it to reveal the true character of the general condition of the atmosphere, which our charts, limited to Europe and the British Isles alone, are powerless to indicate.

*SONNET**

Commemorative of an Incident which occurred in St. Margaret's Church, Westminster, on August 9, 1888.

BEFORE the altar Man and Maid they stood,
On altar-step as Man and Wife then kneeled–
Its Heaven-lent strains the sacred Organ pealed,
Moulding thoughts, hopes, and passions as it would,
Till all hearts swam in one melodious flood.
When as rapt Fancy wandered far a-field
Lo! Eve's fresh bower stood to her sight revealed
Where hung upon the spray a pure white bud—
The bride's half-sister on her nurse's breast–
Fair-writ indenture of prevenient Mind,
An Imogene stole back from far Dream-land
(Spirit of womanhood by a child possessed!)
O'er whose soft gaze, as Ocean deep, inclined
My lips with reverence, kissed her dimpled hand.

New College, Oxford, August 26. J. J. S.

NOTES.

PROF. PIAZZI SMYTH has resigned the office of Astronomer-Royal for Scotland, and no one who takes the trouble to read the second appendix to a paper on "The Edinburgh Equatorial in 1887," contributed by him lately to the Proceedings of the Royal Society of Edinburgh, and now reprinted, will be surprised at his decision. Before he consented to join in the project of the Board of Visitors, about 1870, of applying to the Government for a large equatorial, Prof. Piazzi Smyth pointed out that such an instrument, even if once set up complete, would require further expenditure year after year to keep it fully efficient, and that the working with it would be so peculiarly onerous and responsible that the salaries of the officers of the Royal Observatory, Edinburgh, already acknowledged to be at, or below, starvation point, should be raised more nearly to the level of those of other Observatories or of any ordinary Government offices. He was told that all that was most certainly right, and would be brought about; and the Board of Visitors did most honourably proceed to frame a scheme providing for a modest addition not only to the observers' salaries, but to the available income of the Observatory, to be expended by the Astronomer in instrumental repairs, experiments, and improvements at his discretion. Under these promising circumstances he acted with the Board in their application for a large equatorial. The instrument was in part set up, under the authority of the Office of Works, in 1872; but in the following year, when the erection was found very incomplete, the scheme of the Board of Visitors for increasing the salaries and available income of the Observatory to a point sufficient to finish, maintain, and work the instrument, was suddenly and finally disallowed. A Committee, appointed in 1876 by Mr. (now Lord) Cross to investigate the matter, reported for a series of financial improvements similar to those suggested by the Board of Visitors; but the Home Secretary declined to listen to his own Committee. Another Committee was appointed in 1879. This Committee did not admit the Astronomer to its council, and limited its inquiries to the equatorial. It advised certain improvements, and obtained a grant for executing them; but the grant either still remains in the possession of the Office of Works or has lapsed to the Treasury—a fact which is the less to be regretted as the sum was absurdly inadequate. It would be hard to match this wretched tale in any other civilized country; and we can scarcely expect that science will continue to flourish in Great Britain if its claims are to be treated with so much contempt. Prof. Piazzi Smyth, having withdrawn from his position at Edinburgh, retires to Clova, Ripon, where he will continue his astronomical studies. Warm appreciation of his services during the forty-three years in which he has held office has been expressed on behalf of the Secretary for Scotland, and by the Senatus Academicus of the University of Edinburgh.

THE British Archæological Association, of which the Marquess of Bute is this year the President, began its sittings in Glasgow on Monday. Although this is the forty-fifth annual Congress, it is the first occasion on which the Association has crossed the border.

THE Association of Public Sanitary Inspectors of Great Britain held on Saturday, by invitation of the Mayor (Alderman Martin), a public conference on sanitation in the Royal Pavilion, Brighton. An address by Mr. Edwin Chadwick, the President, who could not be present on account of his advanced age, was read by Dr. B. W. Richardson. The address presented an interesting general view of the recent progress of sanitation in this country.

MR. WILLIAM CHAPPELL, F.S.A., who died on the 20th inst. at his residence in Upper Brook Street, was known chiefly for his efforts to popularize old English music; but he deserves to be remembered also as an ardent student of music in its scientific aspects. He had a wide and accurate knowledge of the natural laws on which the principles of musical composition are based, and his book on the History of Music, both as an Art and as a Science, is of great value. Mr. Chappell was seventy-eight years of age.

MR. P. H. GOSSE, F.R.S., the well-known zoologist, died at his residence, St. Marychurch, Torquay, on the 23rd inst., at the age of seventy-eight. Mr. Gosse was elected a Fellow of the Royal Society in 1856.

MR. WILLIAM A. CROFFUT has been appointed executive officer of the United States Geological Survey, in the place of the late Mr. James A. Stevenson. Mr. Croffut is a well-known journalist, and *Science* anticipates that he will fill with success the difficult position in which he is placed.

CAPTAIN H. FABRITIUS, of the Norwegian Hydrographical Office, is engaged during the present summer in the steamer *Professor Hausteen* in making hydrographical researches on the west coast of Norway, similar to those of last year. The course followed is from Malangen southwards, soundings being taken at about every mile to a distance of some sixty miles from the coast.

SEVERAL recent shocks of earthquake are reported from Norway and Sweden. In the former country an earthquake shock of great severity was felt in various parts of Hardanger, on the west coast, shortly after midnight on July 17. Houses were shaken, and furniture was thrown down. In one place three shocks were felt. The earthquake was accompanied by loud subterranean rumblings. Its area seems to have been very limited: in places only a few miles distant no trace of disturbance was perceived. On July 28, about 3 a.m., a very severe shock of earthquake was felt along a great portion of the northern Baltic shore of Sweden. At Hernösand, Örnsköldsvik, and Lungön, the shocks are reported as particularly severe, houses shaking, &c. In some places two or three shocks were felt, lasting, so correspondents maintain, several minutes. In every place loud subterranean detonations were heard. Again, on the evening of August 17, during a hurricane, a severe earthquake shock was felt in the neighbourhood of Ystad in Scania, in the extreme south of Sweden.

* This sonnet would furnish an unrivalled new situation and a noble subject for a young painter with lofty aims (if such there be among us) to depict. In the church invited to participate in the sacred rite were Star-gazers, Wonder-workers, and Magi (the Darwins, the Thomsons, and the Cayleys), who may be supposed in the person of their representative to be doing homage to the Spirit of Womanhood incarnated in the infant held in the arms of her proud and comely nurse, from whom I learned that the child's name was Imogene.

ON the morning of August 17, about 3 a.m., a remarkable phenomenon attracted attention at the Island of Rügen, in the Baltic. A deep rumbling out at sea was heard, and soon afterwards two enormous waves approached from the north-west, breaking over the shore and doing considerable damage to small craft. At the time the sea was calm, and there was no wind.

ON the night of July 31 a brilliant meteor was seen at Linköping, in Sweden, going in a north-westerly direction. It finally burst, the fragments appearing to fall near the railway park.

Symons's Monthly Meteorological Magazine for August contains an interesting summary of the climate of the British Empire during 1887. Comparing with the summary for 1886, Stanley, Falkland Isles, takes the place of London, as the dampest station. Adelaide has the highest shade temperature, 111°·2; the highest temperature in the sun, 164°; and is the driest station. Winnipeg has the lowest shade temperature, −42°·7, and the greatest yearly range, 135°·9. Bombay has the greatest rainfall, and Malta the least, and also the least cloud. Although the maximum shade temperatures in Australia exceed those in India, the *average* maxima of the latter far exceed those of Australia.

THE Pilot Chart of the North Atlantic Ocean for August shows that although the weather over that ocean was generally fine and very mild during July, a number of depressions were generated, and produced gales over the trans-Atlantic routes. The most violent was one which developed on June 27, in about latitude 42° and longitude 52°, reaching our coasts on July 4. A wind-force as high as 11 of the Beaufort scale was recorded during its course. Dense continuous fog was encountered over and to the westward of the Grand Banks. Large quantities of ice have been reported as far west as the 60th meridian. The tracks of all the most notable August hurricanes on record are plotted on the chart, and show where these dangerous cyclones are likely to be encountered. A supplementary chart showing the derelicts in the North Atlantic, gives also the complete history up to date of the great log raft which was abandoned last December. This most dangerous obstruction to navigation consisted of about 27,000 trunks of trees bound together, and measured 560 feet long. Thousands of the great logs of which it was composed are still drifting over the commercial routes.

IN the *American Meteorological Journal* for July, Lieut. Glassford describes a new wind-vane in use at the California State University. The design is said to possess novel advantages, such as supporting all the weight upon a point, like a compass-card, an oil vessel into which paddles dip to lessen the suddenness of vibration, &c. It may here be mentioned that anemometers with liquid brakes have also been made in this country. Mr. Rotch contributes an article on the Observatory on the Säntis, in Switzerland. The observations of this mountain station are regularly published in the *Annalen* of the Swiss Central Meteorological Office. Mr. F. Waldo gives an abstract of the results of comparisons of several of the combined cistern-syphon barometers, known as the Wild-Fuess check barometers. These portable instruments have been for some time in use in Russia, and some of them are now introduced into the United States Signal Service. The full account of the comparisons was prepared for the Chief Signal Officer's Report, but is not yet printed.

DR. G. N. STEWART, Owens College, sent recently to the Royal Society of Edinburgh a preliminary communication on the electrolytic decomposition of proteids. He pointed out that it is an important question whether the conduction of electricity by animal tissues is mainly or entirely electrolytic. If it is mainly electrolytic, the further question becomes interesting, What are the electrolytes? The inquiry is thus brought into relation with the whole of electro-physiology on the one hand, and the whole of electro-therapeutics on the other, and, at the present moment, it gains special interest from the practical point of view, in connection with the recent introduction of strong currents into gynæcological treatment. The investigation is as yet far from being complete, and Dr. Stewart is at present carrying on the experiments. In the case of egg-albumen it has been found that the resistance at any given temperature is not changed by coagulation, but that it is enormously increased by dialysis. The conclusion is that it is, mainly at any rate, by the electrolysis of the simple inorganic constituents that the current passes.

A THIRD edition of Prof. Silvanus P. Thompson's "Dynamo-Electric Machinery" (E. and F. N. Spon) has just been issued. Most of the treatise has been rewritten for this edition, and much new matter has been added.

THE University College of North Wales has issued its Calendar for the year 1888–89.

IN the Annual Report, for the year 1887, of the Trustees of the American Museum of Natural History, Central Park, New York City, it is stated that the collections of this Museum are now valued at the sum of about 600,000 dollars. "It is but right to say," add the Trustees, "that of this large amount your Trustees have been the main contributors. The necessity of adding to these collections increases as time goes on, and it is hoped that more of our citizens will take an earnest and increased interest in our Museum, and so aid the Trustees in making this institution what it should be and what our city has a right to expect—the great museum of the country."

IN a letter written on board the seal-ship *Jason* in the Denmark Sound, Dr. Nansen draws attention to the scarcity of seals on the coast of Greenland in recent years. Only ten years ago the animals were so plentiful and tame that thousands could be "clubbed" with the greatest ease, whereas now they have become scarce and shy. Dr. Nansen is of opinion that the ruthless persecution of these animals since 1876, when the first sealer appeared in the Denmark Sound, has caused them to alter their habits. Formerly they were found on the edge of the drift-ice, where they were safe from their only enemy, the Polar bear, though falling an easy prey to the sealer. Now they gather on the ice close to the shore, whither vessels cannot penetrate, and where they are, at all events, safe from one enemy. This, says Dr. Nansen, was fully demonstrated on several occasions, particularly on July 2, when seals were seen lying in thousands close under the shore to the north and north-east as far as the eye could reach from the mast-head. To the north especially the ice was for miles one mass of dark animals. Dr. Nansen advocates a closer preservation of the seal. The seal fishery was a failure this year, and sealers report that the ice-masses were enormous.

THE additions to the Zoological Society's Gardens during the past week include three Black-headed Lemurs (*Lemur brunneus*) from Madagascar, presented by Captain J. Bonneville; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Captain James Smith; a Razorbill (*Alca torda*), British, presented by Mr. T. H. Nelson; a Nightingale (*Daulias luscinia*), British, presented by Mr. J. Young; an American Wild Turkey (*Meleagris gallo-pavo* ♂) from North America, presented by Mr. F. J. Coleridge Boles; a Raven (*Corvus corax*), British, presented by Mr. F. Steinhoff; two Pallas's Sand Grouse (*Syrrhaptes paradoxus*), bred in Fifeshire, N.B., presented by Mr. Alexander Speedie; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀) from West Africa, a Vulpine Squirrel (*Sciurus*

vulpinus) from North America, deposited; two Great White Herons (*Ardea alba*), European, purchased; a Moor Monkey (*Semnopithecus maurus*) from Java, a Malabar Squirrel (*Sciurus maximus*) from India, a Red-bellied Squirrel (*Sciurus variegatus*) from Vera Cruz, a Sclater's Curassow (*Crax sclateri* ♀) from South America, a River Jack Viper (*Vipera rhinoceros*) from West Africa, received in exchange; a Wapiti Deer (*Cervus canadensis* ♂), five Brazilian Teal (*Querquedula brasiliensis*), two Chilian Pintails (*Dafila spinicauda*), two Triangular Spotted Pigeons (*Columba guinea*), three Chinese Blue Magpies (*Cyanopolius cyanus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF R CYGNI.—The Rev. T. E. Espin, in Circular No. 21 of the Wolsingham Observatory, reports that he observed a remarkably bright line (apparently F) in the spectrum of this star on August 13. The observation was confirmed on August 22, on which night Dr. Copeland also observed the bright line and determined its position. Dunér's observations of this star in 1879, 1880, and 1882 showed it as possessing a feebly-marked spectrum of the third (Secchi's) type. A change would therefore seem to have taken place in this star. Place for 1887·0, R.A. 19h. 33m. 49s., Decl. 49° 57'·0 N.

MILAN DOUBLE-STAR OBSERVATIONS.—Prof. Schiaparelli has recently published, in No. xxxiii. of the Publications of the Royal Observatory of Brera, the results of his measures of 465 systems of double stars made with the fine 8-inch Merz refractor of that Observatory in the eleven years 1875–85. The observations are nearly 4000 in number, and are for the most part of stars of small distances, *i.e.* less than 5", apart, the binaries in rapid motion receiving especial attention. The measures are grouped together into four parts, the stars of the Dorpat and Pulkowa catalogues forming the first two, then follow stars discovered by Burnham, and those of other discoverers are grouped together in the last. Besides these detailed results of the measures made with the old 8-inch, with which Prof. Schiaparelli has done so much excellent work in the past, there are given in an appendix mean results for a number of the closest pairs as measured with the new 18-inch refractor. Prof. Schiaparelli seems well satisfied with the performance of this new instrument, and records the discovery that the principal star of Σ 1273, ε Hydræ, is itself a very close double, a fact that had hitherto escaped notice, notwithstanding the number of observations which have been made with various telescopes upon the star. The magnitudes of the two components of the new double are 4 and 5·5, and the distance is 0"·2 or 0"·25. The earlier part of the volume contains a detailed description of the optical performance of the 8-inch refractor, a discussion of the errors of the micrometer and of the accidental errors of observation, a determination of the systematic errors of observation, and a very full comparison with Dembowski's measures. The differences in the determination of position-angle due to the varying inclination of the line joining the two stars to the line of the observer's eyes are also investigated, but the reversion prism was not used. Prof. Schiaparelli finds that on the whole his measures of distance are free from systematic errors due to personality, but his position-angles have a tendency to be small as compared with those of other observers.

Amongst the notes to some of the more interesting stars is one on OΣ 285 in which a correction of 180° is suggested to the angles of Englemann and Perrotin in 1883 and 1885, the star being supposed to have passed rapidly through periastron in the long period from 1865 to 1883, in which it was unobserved. All the observations would then be satisfied by an ellipse of 100 years of revolution. Σ 2367 and Σ 2525 are noted as appearing as single stars with the 18-inch refractor in 1887.

ENCKE'S COMET.—Mr. John Tebbutt, Windsor, New South Wales, informs us that he picked up this object on the evening of July 8. Its place as observed closely accorded with that given in Dr. Backlund's ephemeris.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 SEPTEMBER 2–8.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on September 2

Sun rises, 5h. 17m.; souths, 11h. 59m. 21·6s.; sets, 18h. 42m.: right asc. on meridian, 10h. 47·6m.; decl. 7° 40' N. Sidereal Time at Sunset, 17h. 31m.

Moon (New on September 6, 5h.) rises, 0h. 39m.; souths, 8h. 49m.; sets, 16h. 55m.: right asc. on meridian, 7h. 37·2m.; decl. 20° 54' N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° '
Mercury..	6 2 ...	12 33 ...	19 4 ...	11 21·6 ...	5 28 N.
Venus.....	6 35 ...	12 55 ...	19 15 ...	11 43·3 ...	3 12 N.
Mars......	12 26 ...	16 39 ...	20 52 ...	15 27·8 ...	20 24 S.
Jupiter....	12 38 ...	16 58 ...	21 18 ...	15 47·5 ...	19 19 S.
Saturn....	2 43 ...	10 19 ...	17 55 ...	9 6·9 ...	17 19 N.
Uranus ...	8 33 ...	14 9 ...	19 45 ...	12 57·5 ...	5 29 S.
Neptune..	21 28* ...	5 15 ..	13 2 ...	4 2·4 ...	18 59 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich).

Sept.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
2 ...	61 Geminorum ..	6 ...	0 4 ..	0 50 ...	84 216
3 ...	B.A.C. 2854 ...	6 ...	4 54	near approach	135 —

Sept.	h.	
4 ...	1 ...	Saturn in conjunction with and 0° 34' south of the Moon.
7 ...	0 ...	Mercury in conjunction with and 3° 46' south of the Moon.
7 ...	7 ...	Venus in conjunction with and 3° 32' south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° '		h. m.
λ Tauri	3 54·5 ...	12 10 N. ...	Sept. 4,	20 26 *m*
ζ Geminorum ...	6 57·5 ...	20 44 N. ...	,, 8,	21 0 *m*
δ Libræ	14 55·0 ...	8 4 S. ...	,, 6,	21 42 *m*
V Ophiuchi	16 20·5 ...	12 10 S. ...	,, 6,	*M*
U Ophiuchi	17 10·9 ...	1 20 N. ...	,, 4,	1 15 *m*
			,,	21 22 *m*
W Sagittarii ...	17 57·9 ...	29 35 N. ...	,, 8,	1 0 *m*
β Lyræ	18 46·0 ...	33 14 N. ...	,, 7,	23 0 m_2
R Lyræ	18 51·9 ...	43 48 N. ...	,, 2,	*M*
S Vulpeculæ ...	19 43·8 ...	27 1 N. ...	,, 2,	*M*
η Aquilæ	19 46·8 ...	0 43 N. ...	,, 7,	0 0 *M*
R Sagittæ	20 9·0 ...	16 23 N. ...	,, 6,	*m*
X Cygni	20 39·0 ...	35 11 N. ...	,, 5,	3 0 *M*
T Vulpeculæ ...	20 46·7 ...	27 50 N. ...	,, 2,	3 0 *M*
δ Cephei	22 25·0 ...	57 51 N. ...	,, 4,	1 0 *m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near Algol	43 ...	39 N. ...	Swift; streaks.
,, ε Lyræ	282 ...	42 N. ...	Swift; bright.
,, β Piscium	345 ...	1 N. ...	Slow; bright.

GEOGRAPHICAL NOTES.

THE current number of the Proceedings of the Royal Geographical Society contains the report of his first year's work by Mr. Mackinder, the Reader in Geography to the University of Oxford, whose appointment is due to the Society. He describes the year as one of reconnoitre and preparation; nevertheless he delivered forty-two ordinary lectures in the University, and one public lecture; in each of the three terms he lectured for seven weeks twice a week, having two courses going on side by side on different days, to one of which he imparted a scientific, to the other an historical bias. The notices were, by permission of the Board of Faculties, published in the lists of two separate Faculties—Natural Science and Modern History. On the scientific side the lectures have been on the principles of geography—"a review of the subject not merely physical, yet taking the feature, and not the region, as the basis of classification." This course has not been so well attended as the other, but Mr. Mackinder congratulates himself that he has never been wholly without an audience, "a fate not altogether unknown just now to Oxford Professors and Readers." On the historical side the lectures were on the geography of Central Europe, and the influence of physical features on man's movements and settlements. "My aim is

to furnish general instruction to as large a number as will favour me with their attention; and also to have always round me two or three whom we may style specialists. I can only say that I now see a very fair prospect of obtaining the latter. It may be well to place on record my humble opinion, that the best preliminary training for a geographical *specialist* is sound grounding in general science, and superadded to this an elementary knowledge of history. I have found by experience that it is exceedingly hard to give the necessary scientific knowledge to an historian"—a somewhat hard saying for the historians. In the coming academical year the lectures will be on the physical geography of continents, the geography of the British Isles, and the historical geography of North America. As Extension Lecturer, Mr. Mackinder has delivered 102 lectures on geography and physiography at various towns throughout the country.

IN the August number of the *Scottish Geographical Magazine*, Mr. Forbes reports on his attempts to reach the Owen Stanley Peak, and incidentally describes the moving adventures by flood and field of his last expedition. Although not successful, owing to more than one unexpected mishap, in reaching his goal, he claims that the results accomplished so far have not been few or inconsiderable. Large additions have been made to botanical and some to zoological science; an extensive series of meteorological observations has been tabulated, and a tract of country has been mapped for the first time. Mr. Ravenstein briefly describes the recent explorations in the territories of the African Lakes Company between Nyassa and Tanganyika. Both these papers are accompanied by excellent maps. Archdeacon Maples, of the Universities Mission to Central Africa, gives a detailed account of Lukoma, the principal island in Lake Nyassa, which, although only 4½ miles long by 2½ broad, has a population of 2500, or about 220 to the square mile, in consequence of its comparative freedom from war. "Ula," or witchcraft, of the kind described by Mr. Rider Haggard with such graphic force in one of his earlier works, prevails, and is a curse to the island. Herr Metzger contributes a most interesting paper on the scientific work lately done in the Dutch East Indies, based mainly on recent Government publications and those of various learned Societies in Holland and Java.

THE current number of the *Deutsche Geographische Blätter* contains two papers of considerable geographical and ethnological interest. The first, by Herr August Fitzau, is devoted to the little-known region of the north-west African seaboard between Morocco and the Senegal River. After an historical survey of the various attempts made to found European settlements in this region, the writer describes in detail the sections of the coast between Agadir and Cape Juby, and thence to Saint Louis. He then deals with the Western Sahara in general, and especially with the ethnological relations of the regions south of the Atlas and north of the Senegal River, arriving at the general conclusion that, although Arabic has become the dominant language, the old Berber or Hamitic is still the prevailing ethnical element, variously modified by Semitic and Negro influences. In the second paper the distinguished traveller and ethnologist, Dr. O. Finsch, gives a sympathetic and permanently valuable account of the life and work of the late Mikluho-Maclay, to whom anthropological science is so much indebted for his profound studies of the Malayan, Papuan, Negrito, Melanesian, and Australian races. The memoir is very complete, including a detailed account of the naturalist's travels with their scientific results, his vast ethnological collections and the zoological stations founded by him, and concluding with a full descriptive catalogue of his numerous geographical, anthropological, and zoological writings.

THE July number of the *Bollettino* of the Italian Geographical Society is mainly occupied with Leonardo Fea's recent explorations in Tenasserim. The chief points visited were the curious "Farm Caves" in the Moulmein district, and Mount Mulai (Moolaee) in the Dona Range. This peak, culminating point of Tenasserim (6300 feet), was reached and ascended to its summit after a journey full of difficulties and hardships, which followed the course of the Jeeayng-Myit and its great southern tributary, the Undurò, as far as Meetan in 46° N., 98° 30′ E. From Meetan the route struck north to Tagata and Mulai through the hilly territory of the little-known Ayaeen Karens. Of this tribe Signor Fea gives an interesting account, and he was also successful in securing a large zoological collection, including 450 skins of birds, over 400 mammals, many hundred reptiles, batrachians, and fishes, besides numerous insects, spiders, mollusks, and other small animals. These treasures go to enrich the valuable zoological materials already brought together in the Natural History Museum founded at Genoa by the Marquis Giacomo Doria. The paper is accompanied by a map of the region explored, as well as by several original sketches by the naturalist himself. The Marquis Doria has added a useful list of the various memoirs that have appeared in connection with Signor Fea's geographical and biological researches in Burmah during the last four years.

THE most important amongst recent explorations in Indo-China are those undertaken by the Vice-Consul for France at Luang Prabang, the capital of an outlying region of Siam of the same name, and itself situated on the Mekong. M. Pavie, the official in question, has since succeeded in reaching Tonquin from this place by two different routes, the most practicable apparently being that to the north-east along the valley of the Namseng, a tributary of the Mekong, and then across the mountains forming the watershed of the Mekong and Songkoi, or Red River of Tonquin, to the valley of Nam Tay or Black River, down which M. Pavie proceeded to Sontay and Hanoi.

AT a recent meeting of the Swedish Geographical and Anthropological Society, Baron H. von Schwerin gave an account of his late expedition to the Congo and West Africa, extending over a period of nearly two years, and undertaken at the instance of the Swedish Government. He had proceeded in a steamer as far up the Congo as Stanley Falls, and then up the Kassai, the principal tributary of the former. Next he had, in the company of his countryman, Lieut. C. Håkansson, explored the basin of the Inkissi, another tributary of the Congo, and from Banana made an excursion into the land of the Mushirongi, south of the mouth of the river, a country never hitherto visited by any European. After a journey to Angola and Mossamedes, on the west coast, a journey performed in a sailing-vessel, and extending as far north as Cape Negro, he made an excursion into the lands of Kakongo and Kabinda, situated to the north of the mouth of the Congo, which had also hitherto been considered closed to Europeans. The heat on the Congo was not so excessive as was generally imagined. A temperature above 35° C. was rare, but what were particularly enervating and exhausting were the steadiness of the high temperature and the total absence of cooling breezes, whether in the shade or at night, and, more than either, the excessive humidity of the air. He considered the climate of the Congo one of the healthiest in Africa. Finally, Dr. Schwerin gave an account of his discovery on the promontory south of the Congo River of the remains of the marble pillar raised there in 1484 by Diego Cam in commemoration of the discovery of this mighty river, and destroyed by the Dutch in the sixteenth century. The speaker also exhibited a large and valuable collection of scientific objects gathered in Africa.

NOTES ON METEORITES.

I.

THEIR FALL AND PHYSICAL CHARACTERISTICS.

A PERUSAL of the Chinese annals—which reach back to the year 644 before our era, and are still models of patient record—or of the much more irregular and less complete ones of the Western world, shows in the most definite manner that since the very commencement of human history, from time to time falls of bodies on to the earth from external space have been noticed. Biot has traced in Ma-tuan-lin the record of sixteen falls from the date before mentioned to A.D. 333.

The earliest fall recorded in Europe, however, transcends in antiquity anything the Chinese can claim, dating as it does from 1478 B.C. It happened in Crete, but the record is much more doubtful than that of the falls in 705 and 654 B.C., noted, the first by Plutarch, and the second by Livy.

But in 466 B.C. occurred a fall at Aegos Potamos, in Thrace, concerning which the Chronicles of the Parian marbles, Plutarch, and Pliny all give us information. It was of the size of two mill-stones, and equal in weight to a full waggon-load.[1] Later, there fell in Phrygia, in about the year 204 B.C., a stone famous through long ages, which was preserved there for many generations. It was described as "a black stone, in the figure of a cone, circular below and ending in an apex above." It was worshipped by the ancients as Cybele, the mother of the gods,

[1] Humboldt, "Cosmos," Otté's translation, vol. i. p. 103.

and was transferred to Rome, as an oracle had announced that the possession of it would secure continual prosperity to the State.[1]

In more modern times we have records of various falls of these bodies. The following—a few out of a very great number—either possess a national interest or are the statements of eye-witnesses.

In England there fell a stone in the afternoon of December 13, 1795. A labourer happened to be working near Wold Cottage, Thwing, Yorkshire, when this stone fell within a few yards of him. On digging the stone out of the ground it was found to have penetrated a foot of soil and half a foot of chalk rock, and to weigh 56 pounds. The inhabitants of the neighbouring villages likened the explosion to the firing of guns at sea, while in two of them the sounds were so distinct of something rushing through the air towards Wold Cottage that some of the people went to see if anything extraordinary had happened.

The next account is from Ireland. It is the narrative of an eye-witness of a fall of meteorites in the county of Limerick.

"Friday morning, the 10th of September, 1813, being very calm and serene, and the sky clear, about 9 o'clock, a cloud appeared in the east, and very soon after I heard eleven distinct reports appearing to proceed thence, somewhat resembling the discharge of heavy artillery. Immediately after this followed a considerable noise not unlike the beating of a large drum, which was succeeded by an uproar resembling the continued discharge of musketry in line. The sky above the place whence this noise appeared to issue became darkened and very much disturbed, making a hissing noise, and from thence appeared to issue with great violence different masses of matter, which directed their course with great velocity in a horizontal direction towards the west. One of these was observed to descend; it fell to the earth, and sank into it more than a foot and a half, on the lands of Scagh, in the neighbourhood of Patrick's Well, in the county of Limerick. It was immediately dug up, and I have been informed by those that were present, and on whom I could rely, that it was then warm and had a sulphurous smell. It weighed about 17 pounds, and had no appearance of having been fractured in any part, for the whole of its surface was uniformly smooth and black, as if affected by sulphur or gunpowder. Six or seven more of the same kind of masses, but smaller, and fractured, as if shattered from each other or from larger ones, descended at the same time with great velocity in different places between the lands of Scagh and the village of Adare. One more very large mass passed with great rapidity and considerable noise at a small distance from me; it came to the ground on the lands of Brasky, and penetrated a very hard and dry earth about 2 feet. This was not taken up for two days; it appeared to be fractured in many places, and weighed about 65 pounds! Its shape was rather round, but irregular. It cannot be ascertained whether the small fragments which came down at the same time corresponded with the fractures of this large stone in shape or number, but the unfractured part of the surface has the same appearance as the one first mentioned. There fell also at the same time, on the lands of Faha, another stone, which does not appear to have been part of or separated from any other mass; its skin is smooth and blackish, of the same appearance with the first-mentioned; it weighed about 74 pounds; its shape was very irregular, for its volume was very heavy. . . . . . It was about three miles in a direct line from the lands of Brasky, where the very large stone descended, to the place where the small ones fell in Adare, and all the others fell intermediately; but they appeared to descend horizontally, and as if discharged from a bomb and scattered in the air."[2]

The fall of the meteorite of 1885, near Mazapil, in Mexico, was thus described by an eye-witness vouched for by Prof. Bonilla:—[3]

"It was about nine in the evening when I went to the corral to feed certain horses, when suddenly I heard a loud hissing noise, exactly as though something red-hot was being plunged into cold water, and almost instantly there followed a somewhat loud thud. At once the corral was covered with a phosphorescent light and suspended in the air were small luminous sparks as though from a rocket. I had not recovered from my surprise when I saw this luminous air disappear, and there remained on the ground only such a light as is made when a match is rubbed. A number of people from the neighbouring houses came running toward me, and they assisted me to quiet the horses, which had become very much excited. We all asked each other what could be the matter, and we were afraid to walk in the corral for fear of getting burned. When, in a few moments, we had recovered from our surprise, we saw the phosphorescent light disappear, little by little, and when we had brought lights to look for the cause, we found a hole in the ground and in it a ball of fire. We retired to a distance, fearing it would explode and harm us. Looking up to the sky we saw from time to time exhalations or stars,[1] which soon went out, but without noise. We returned after a little, and found in the hole a hot stone, which we could barely handle, which on the next day we saw looked like a piece of iron; all night it rained stars, but we saw none fall to the ground, as they seemed to be extinguished while still very high up."

The next record of the phenomena attending a fall in the United States (though the observer quoted did not actually see the fall) is taken from a lecture by Prof. Newton:—[2]

"'The observers,' he says, 'who stood near to the line of the meteor's flight, were quite overcome with fear, as it seemed to come down upon them with a rapid increase of size and brilliancy, many of them wishing for a place of safety, but not having the time to seek one. In this fright the animals took a part, horses shying, rearing, and plunging to get away, and dogs retreating and barking with signs of fear. The meteor gave out several marked flashes in its course, one more noticeable than the rest. . . . Thin clouds of smoke and vapour followed in the track of the meteor. . . . From one and a half to two minutes after the dazzling, terrifying, and swiftly moving mass of light had extinguished itself in five sharp flashes, five quickly recurring reports were heard. The volume of sound was so great that the reverberations seemed to shake the earth to its foundations; buildings quaked and rattled, and the furniture that they contained jarred about as if shaken by an earthquake; in fact, many believed that an earthquake was in progress. Quickly succeeding, and blended with the explosions, came hollow bellowings and rattling sounds, mingled with clang, and clash, and roar, that rolled away southward, as if a tornado of fearful power was retreating upon the meteor's path.'

"About 800 pounds of stones, nearly 200 in number, have been picked up in a region seven miles by four, a little east of the end of the meteor's path, which without any doubt came from the meteor. Some were picked up on the surface of the frozen ground. One was found on the top of a snow-bank, and about 40 feet away were marks of a place where it had first struck the ground. Some were ploughed up in the spring. The two largest found, of 74 pounds and 48 pounds, fell by the roadside, and a law-suit to settle whether they were the property of the finder as being wild game, or of the owner of the lands adjacent as being real estate, was decided in favour of the owner of the land."

In some cases of observed falls the rate of movement of the meteorite through the air has been determined, or concomitant circumstances have enabled it to be roughly estimated.

The velocities have been widely different. Before they are stated, s me terms of comparison may be given:—

		Metres per second		Miles an hour.
Railway trains		27 nearly	...	60
Flight of swallow		30 to 40	...	67 to 92
Projectiles		300 to 400	...	670 to 920
Sound		$335\frac{1}{3}$ nearly	...	750
Mercury	Movement in Orbit ...	48,900	...	109,358
Venus	...	36,780	...	83,162
Earth	...	30,430	...	68,052
Mars	...	24,650	...	55,135·5

The highest velocity of flight through the air has been that of the Stannern meteorites, 45 miles a second. The lower part of the flight of the Iowa meteorite was performed at 12 miles a second.

In only a few cases have the velocities been observed to be very great at the earth's surface, the retarding effect of the passage through the atmosphere being considerable. Some have buried themselves deeply in the ground, and one (New Concord) broke a railway-sleeper. Several meteorites have fallen so rapidly that the sound of the explosion *followed* them. But generally the rate is so slow that they are not broken on striking

[1] See British Museum Introduction to the Study of Meteorites, p. 17.
[2] Quoted by Maskelyne, "Lecture Notes on Meteorites," NATURE, 1875, vol. xii. p. 485.
[3] NATURE, vol. xxxv. p. 572.

[1] The meteor fell during a star-shower.
[2] NATURE, vol. xix. p. 315.

the surface, and some that fell at Hessle on ice only rebounded without cracking it.

These bodies, when they fall under such conditions that they can be picked up and examined, are called meteorites. The first thing that strikes one when looking for the first time at these meteorites, is that their general form has the character of being essentially fragmentary, indicating that what we see is the result of a fracture.

The next point observed is that there is a very great difference between the interior and exterior appearances of these bodies. That this is caused by the heat and friction to which the exterior surface is exposed is proved by what was noticed in the case of a meteorite that fell at Butsura in 1861. Fragments of this stone were picked up three or four miles apart, and, with the exception of one corner, the original meteorite has been built up again by piecing the fragments together. The faces fit perfectly. Important pieces of this meteorite are in the British Museum, and these are all coated with the crust to which reference has been made. But, on the other hand, another of these fragments *not coated* fits another also not coated. Hence, to quote Prof. Maskelyne, "We can assert that this aërolite acquired, after coming into our atmosphere, a scoriated and blackened surface or incrustation. The first explosion drove the fragments first alluded to asunder, and these became at once incrusted on their broken surfaces; but others which were separated afterwards, probably on the last of the three explosions, had not sufficient velocity left [the heat being at the same time reduced] to cause their incrustation in the same manner as was the case with the fragments previously severed."[1]

The supposition is that the temperature is practically high enough to melt the meteorite, and that its surface as we see it after it has fallen does not in all cases represent the surface exposed to the air during the whole of the flight, but that it represents the last surface. The meteorite may have been twenty times bigger, but the rest may have been melted off like tallow would be, so that finally there is very little visible effect towards the interior, as the melting is more rapid than the conduction. The thinness of the so called varnish, then, is caused by the air-molecules carrying away the results of fusion as fast as the heat penetrates towards the interior, so leaving only, as a rule, a very thin film behind.

This crust is usually dull, but sometimes, as in the Stannern meteorite, bright and shining, like a coating of black varnish.

FIG. 1.—Mazapil Meteoric Iron (3/4 natural size), showing thumb-marks.

Sorby,[1] on examining with a microscope a thin section of a meteorite, cut perpendicular to the crust, found that it is a true black glass filled with small bubbles, and that the contrast between it and the main mass of the meteorite is as complete as possible, the junction between them being sharply defined, except when portions have been injected a short distance between the crystals. He writes:—"We thus have a most complete proof of the conclusion that the black crust was due to the true igneous fusion of the surface under conditions which had little or no influence at a greater depth than 1/100 of an inch. In the case of meteorites of different chemical composition, the black crust has not retained a true glassy character, and is sometimes 1/50 of an inch in thickness, consisting of two very distinct layers, the internal showing particles of iron which have been neither melted nor oxidized, and the external showing that they have been oxidized and the oxide melted up with the surrounding stony matter. Taking everything into consideration, the microscopical structure of the crust agrees perfectly well with the explanation usually adopted, but rejected by some authors, that it was formed by the fusion of the external surface, and was due to the very rapid heating which takes place when a body moving with planetary velocity rushes into the earth's atmosphere—a heating so rapid that the surface is melted before the heat has time to penetrate beyond a very short distance into the interior of the mass."

[1] "On the Structure and Origin of Meteorites," NATURE, vol. xv. p. 495.

In some cases close under the crust is found a mixture of the minerals troilite, asmanite, and bronzite, of an unaltered light-brown colour, although they turn deep black when raised to a temperature slightly above that at which lead melts.[2]

The crust or varnish of the meteorite in many cases contains numerous furrows and ridges, so that it is not equally thick. This effect is caused, as it is supposed, by its motion through the air in a fixed position, the forward part of the meteorite, in regard to its line of motion, being most liquefied, and the liquid flowing unequally towards the hinder part.

A very special study of the results of the passage through the air is a desideratum. Thus, in the case of the Tennessee iron, which fell from a cloudless sky (and which therefore fell with a low velocity?), the outer surface is elaborately reticulated, edges

[1] "Lecture Notes," *loc. cit.* p. 487.
[2] Flight, "History of Meteorites," p. 169.

of thin laminæ of metal inclined at angles of 60° traversing it. Hence no fusion of the superficial layer took place.[1]

Another peculiarity of the surface is that it is generally covered with small depressions called "thumb-marks," as they have been likened to the impressions that one makes when pressing some such substance as putty with one's fingers. The cause of these thumb-marks is unknown, but they have been found to bear a close resemblance to marks which have been noticed on grains of gunpowder blown out on firing large guns.

A possible cause of these pittings is thus suggested by Prof. Maskelyne:—"The aërolite comes into our atmosphere from regions in which the temperature—'the cold of space'—may range as low as 140° C. below zero; and though the mass, from the absorption of solar heat, would possess a temperature much above this, it would nevertheless be intensely cold, and consequently more brittle than at ordinary temperatures; and hence, on its entering our atmosphere, the heat it instantaneously acquires on its outer portion expands this, and tends to tear it away, so as to dissever the exterior from the interior, which continues to be relatively contracted by the intensity of the cold which the aërolite brings with it from space. The consequence is, first, that little bits of the stone spring out all over it, leaving those curious little holes or pit-marks which are characteristic of a meteorite; and every now and then, as the heat penetrates, larger masses split away, of which interesting evidence is afforded by the meteorite, for instance, that fell at Butsura on May 12, 1861."

On this it may be remarked that the pittings are common to irons and stones, while the above explanation only applies to stones.

It is not a little worthy of notice that the pitting does not always appear on all the surfaces. In the case of a meteorite which fell in Kentucky in 1877, one portion of it is very extensively and regularly pitted, while the rest is comparatively smooth. The crust is dull black, and is as perfect as when the stone fell. There was a fresh broken spot of two or three square centimetres, which was evidently made prior to the fall, for a few small specks of the melted matter adhered to the surface.[2]

These meteorites, which we can thus examine, are in all probability, for the most part, remnants of larger bodies which had enough substance in them to stand the wear and tear of getting through our atmosphere.

The fragments picked up even from the most extensive falls have appeared to those who have witnessed or who have subsequently studied the phenomena to be out of all proportion small to the violence and magnitude of the explosive and luminous effects observed.

The origin of the concomitant phenomena so universally recorded is not far to seek.

Supposing a meteorite passing towards the earth through the atmosphere, what sort of effects are we to expect to find? It passes, as we have already seen, very rapidly into the earth's atmosphere, which consists of molecules with a certain mean free path, and the temperature and pressure of which depend upon the encounters between these molecules.

When we come to consider the general velocity of movement of these molecules, we find that the big molecule, the meteorite, is travelling towards the earth about fifty times faster. The result is that there is a tremendous crowding of air, so to speak, in front of the meteorite, a tremendous pressure and therefore a tremendous temperature brought about by its passage. There is a partial vacuum behind which subsequently has to be filled up by the transit of the molecules round the meteorite itself from the front part to the back.

We have therefore conditions for producing most violent action upon the meteorite, both by pressure and temperature; it may be crushed by the pressure to which it is subjected, it may be melted by the heat produced by the circulation of the molecules rushing past it. We may therefore have violent incandescence and explosion, and as we have the air molecules rushing violently from front to rear we shall have almost the noise of a thunderstorm added to the sudden luminosity resembling lightning.

The observers of actual falls have heard other special noises, due, not to the explosion itself, but to the rapid passage of the meteorites through the air, from the "ping" of a rifle bullet to the hum of a locomotive, sounds which have been likened to the tearing of linen, the lowing of cattle, the flapping of wings.

We can best study the differences in the structure of meteorites by preparing a polished section. In some cases this has a distinctly metallic look. We find, in fact, a metallic fragment composed almost entirely of iron, but with a certain amount of nickel.

The nickel in the iron meteorites causes them to have a whitish appearance, and it is in this way that they have been mistaken for silver when found, the nickel preventing the outer surfaces from rusting as is the case with an ordinary iron.

By taking a polished section, and exposing it to the action of an acid or bromine, we obtain what have been called the "figures of Widmanstätten." These figures are more or less complicated, and remarkable for their extreme regularity. They are due to the inequality of the action of the acid on the various constituents of the polished surface; these being various alloys of iron and nickel.

In other specimens the characteristic is that the metal, instead of being continuous as in those previously referred to, appears to have existed once as a spongy paste, and to have included fragments of stony matter, so that in the section, instead of getting the pure metallic lustre all along, we only get it here and there. We pass from metal to metal *plus* stone.

In yet other specimens we get another generic case represented in which the stone is the main point and the metal the exception, the metal appearing as excessively small granules; so that in the final term of the series we come to almost pure stone with no iron to speak of.

In the case of the stones, not only does the meteorite itself give the idea of a fragment, as in the case of the irons, but the internal structure of many of them shows that the whole meteorite is composed of fragments, giving the characteristics of a brecciated rock made up of pieces cemented together.

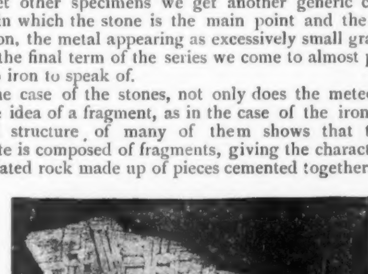

FIG. 2.—Section of Mazapil Meteoric Iron (natural size), showing Widmanstätten figures.

Further, these constituent particles, as pointed out by Sorby, are often themselves mere fragments, although the entire body before being broken may originally have been only one fortieth or one-fiftieth of an inch in diameter.

On examining thin sections of stony meteorites by means of polarized light, they are found to be crystallized throughout, the interference tints colouring the different crystals of which the sections are composed, thus showing the crystalline character of the whole. The stony part of both siderolites and aërolites is almost entirely crystalline, and presents a peculiar "chondritic" structure, which make meteorites differ from ordinary terrestrial rocks; the loose grains in these are found to be more or less aggregated in little spherules, and of similar mineral to those which inclose them.

These spherules, or chondroi—their sizes varying very considerably, some of which can be seen only under a microscope, while others are as large as a cherry—are found embedded in a matrix, made up, as it appears, of minute splinters such as would result from the disintegration of other chondroi.

While the chondroi in terrestrial rocks such as perlite, obsidian, pitchstone, and in many diorites, are radiate-fibrous, those occurring in meteorites are but rarely so, and the arrangement of the fibres within the spherule is eccentric. While the meteoritic chondroi also consist of the same ingredients as the matrix, and often differ from it only in being more coarsely granular, the chondroi of terrestrial rocks are differently constituted from the matrix.[1]

The weight of meteorites varies very considerably, ranging from tons to very small specimens. It not only depends on their volume but on their chemical composition, as some of the stony ones have a low density while others are nearly pure metal.

The largest meteorites of which mention is made are those

[1] Flight, *op. cit.* p. 108. [2] *Ibid.* p. 200.

[1] *Ibid.* p. 141.

of Otumpa (province of Tucuman, South America), an iron weighing thirty tons; of Durango (Mexico), nineteen tons; and of Cranbourne, Australia (now in the British Museum), which weighs over three tons.

The Nejed iron, the largest which has been seen to fall, weighs nearly 130 pounds.

Considering the very considerable number of falls which have taken place, the number of irons which have been *seen to fall* is remarkably small. They are as follows:—

Agram, 1751.
Tennessee, 1835.
Braunau, 1847.
Victoria West (South Africa) 1862.
Nejed, 1863.
Nidigullam (Madras) 1870.
Rowton, Shropshire, 1876.
Mazapil, 1885.
Cabin Creek, 1886.

The following table contains a list of some of the larger meteorites, besides those mentioned above, which have been found from time to time, with the locality of their fall and their weights in grammes (1000 grammes = 2·2 pounds avoirdupois (nearly), and 1,018,181 grammes (nearly) = 1 ton):—

	Weight in grammes.
Siderites—	
Bahia, Brazil...	6,350,000
Charcas, Mexico	780,000
Tucuman, Argentine Republic, South America	637,000
The Butcher Iron, Desert of Bolson de Mapimi, Mexico	253,632
Toluca Valley, Mexico	91,007
Cocke County (Cosby's Creek), Tennessee, U.S.A.	52,325
Rancho de la Pila, nine leagues east of Durango, Mexico	46,512
Obernkirchen, near Bückeburg, Germany	35,366
Carthage, Smith County, Tennessee, U.S.A.	24,570
Siderolites—	
Imilac, Desert of Alacama, South America	227,328
Estherville, Emmet County, Iowa, U.S.A.	116,487
Aërolites—	
Wold Cottage, Thwing, Yorkshire	20,111
Pultusk, Poland	18,007
Butsura (Qutahar Bazaar), Bengal, India	13,071
Knyahinya, near Nagy Berezna, Hungary	13,053
Durala, N.W. of Kurnal, Punjab, India	12,588
Dhurmsala, Kangra, Punjab, India	12,407
Nellore (Yatoor), Madras, India	11,287

Classification of Meteorites.

Meteorites have been arranged into three classes: first, masses of iron alloyed with nickel, which have been called by Maskelyne, aëro-siderites (*aer*, air, and *sideros*, iron) or briefly siderites; secondly, those which are almost wholly composed of stone, and called aërolites (*aer*, air, and *lithos*, stone); and, thirdly, those which are composed of stone and iron in more or less equal quantities, consisting of a spongy mass of iron interlaced with stony matter like that of the aërolites, and called siderolites or meso-siderites.

M. Daubrée's general classification of meteorites is as follows:—

Meteorites	Containing metallic iron	Not containing stony matter	... ...	Holosidères
		Containing iron with stony matter	The iron constituting a matrix which encases stony grains ...	Syssidères
			The iron existing in the form of grains among stony matter ...	Sporadosidères
	Not containing metallic iron		.. ..	Asidères

This brings us to consider the chemistry of these messengers from the celestial spaces. J. NORMAN LOCKYER.

(*To be continued.*)

THE GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

AT the present time, when so much is being said and done in connection with technical education, and so many new institutions are being founded, it may interest the readers of NATURE to learn how some old ones have been reorganized to enable them more adequately to meet the requirements of the times. The Glasgow and West of Scotland Technical College was founded by an Order of the Queen in Council, dated November 26, 1886, according to a scheme framed by the Commissioners appointed under the provisions of the Educational Endowments (Scotland) Act, 1882, whereby Anderson's College, the Young Chair of Technical Chemistry in connection with Anderson's College, the College of Science and Arts, Allan Glen's Institution, and the Atkinson Institution, were placed under the management of one governing body. A considerable amount of interest is attached to the histories of these institutions, of which a few of the chief dates may be mentioned.

Anderson's College was founded by John Anderson, M.A., F.R.S., Professor of Natural Philosophy in the University of Glasgow, who, by his will, dated May 7, 1795, bequeathed the whole of his property, with a few trifling exceptions, "to the public for the good of mankind and the improvement of science, in an institution to be denominated 'Anderson's University,' and to be managed by eighty-one trustees." The endowment included a general museum, library, and valuable philosophical apparatus; and the intention of the founder was to provide a complete circle of liberal and scientific education suitable for all classes, and adapted to the wants and circumstances of the period, but the design was never fully carried out. The Andersonian Institution or University was incorporated on June 9, 1796, and it has numbered among its Professors some distinguished men. Of these may be named Dr. Garnett, Dr. George Birkbeck, Dr. Andrew Ure, and Thomas Graham, who afterwards became Master of the Mint. The Medical School attained considerable importance, attracting students from all parts of the country, and sending forth a number of medical practitioners—many of whom have attained to eminence, and a few to great distinction, in their profession. On the foundation of the Glasgow and West of Scotland Technical College, the Medical School of Anderson's College was placed under a separate governing body, and provision is being made for its removal to other buildings.

In the year 1870, Dr. James Young, of Kelly and Durris, settled in trust the sum of £10,500 for the purpose of establishing a Chair of Technical Chemistry, to be called "The Young Chair of Technical Chemistry in connection with Anderson's University," and on the organization of the Glasgow and West of Scotland Technical College, Dr. Young's testamentary trustees conveyed to the governors of the College the Young Laboratory Buildings, situated in John Street, Glasgow. Various other endowments were given at different times to Anderson's University. In 1861, Mr. John Freeland, residing at Nice, mortified the sum of £7500 to secure the delivery, annually or periodically, of "separate courses of popular lectures on the three following subjects, or any one of them, namely (1) Chemistry; (2) Mechanical and Experimental Physics; and (3) Anatomy and Physiology," and in 1871 he made a further gift of £5000 to the University. In 1866, Mr. William Euing, insurance broker in Glasgow, settled in trust the sum of £3000 for the purpose of securing the delivery of courses of popular lectures in Anderson's University upon the history and theory of music, and upon the lives of eminent musicians; and also upon such branches of acoustics as may be connected with and illustrate the science and practice of music. By his will he bequeathed his whole musical library to the University, along with £1000 for the purpose of building a fire-proof room for its accommodation, besides the sum of £200 to print a catalogue. Mr. Euing also left the University the sum of £6000 for general purposes; and £150, the interest of which is to be applied in providing prizes in connection with the Lectureship on Music instituted by him. In 1876, through the liberality of a few friends, a Chair of Applied Mechanics, with a suitable endowment, was founded.

The College of Science and Arts was the direct successor of the Mechanics' Institution, which owed its origin to the popular lectures begun in 1800 by Dr. Birkbeck in Anderson's University, and continued by his successor. In 1823 a number of students attending these mechanics' classes resolved to sever their connection with Anderson's University, and thereafter

formed the Glasgow Mechanics' Institution, of which Dr. Birkbeck became the first President. He also became President of the Mechanics' Institution in London, which was opened in November 1823, on the same plan as that of Glasgow, after which the system rapidly extended over the Kingdom. In 1879 the Institution was reorganized, and two years later the name was changed to "College of Science and Arts, Glasgow," from which time the commercial classes were discontinued, and the College classes entirely devoted to the teaching of science and its applications, more especially to engineering.

Allan Glen's Institution was founded under the will of Allan Glen, wright in Glasgow, dated 1847-48, and was intended to afford gratuitous education to about fifty boys, sons of tradesmen or persons in the industrial classes of society. In 1876 the Institution was reorganized, and it became a high-class secondary school for boys who are intended for industrial and mercantile pursuits. The trustees fitted up a laboratory, lecture-room, apparatus-room, and workshops in the school, which soon became well known for the good secondary technical instruction which it afforded.

The Atkinson Institution never really had an active existence, and the interest of the money which was left by Thomas Atkinson, bookseller and stationer in Glasgow, is now to be used in providing bursaries for the students attending the Glasgow and West of Scotland Technical College.

Provision is made under the scheme for the further endowment of the College by annual subsidies out of the funds of the Glasgow City Educational Endowments Board and the Hutcheson's Educational Trust. These subsidies are fixed in the special schemes for these Boards at not less than £800 and £1400 respectively.

By the scheme drawn out by the Educational Endowments (Scotland) Commissioners, the institutions above referred to have been amalgamated and placed under the management of one governing body, which has been selected from among the representatives of the old institutions and from various public bodies in Glasgow. The problem which the governing body had to solve was to arrange a number of hitherto competing and to a certain extent opposing institutions into something like a homogeneous unity. Of course under the circumstances it is not to be expected that a perfect scheme can at once be evolved, but on the whole it will be found that a fairly good arrangement has been made. Allan Glen's School is being extended, and is intended to be a secondary technical school for boys to sixteen years of age; while Anderson's College, the Young Chair, and the College of Science and Arts form the College proper. For entrance to this, students under sixteen years and all those who intend to go in for any of the diploma courses are required to pass an examination, but this is not so difficult as to exclude those who are likely to benefit by the work of the College classes. The diploma of the College will be awarded in the following departments of study: (1) Civil Engineering; (2) Mechanical Engineering; (3) Naval Architecture; (4) Electrical Engineering; (5) Architecture; (6) Chemical Engineering; (7) Metallurgy; (8) Mining Engineering; (9) Agriculture. Each course extends over three years, the subjects of instruction in the first year being common to all, while in the second and third years the subjects are arranged to suit the special departments selected by the students. There are three sets of examinations for the diploma: (1) at the end of the first session, in the scientific subjects of the first year's course; (2) at the end of the second session, in the modern language and the general subject selected by the student; (3) at the end of the third session, in the main subject of the department selected by the candidate. This examination will be partly by written papers and partly oral, and will be of such a nature as not only to test the candidate's knowledge of the main subject, but also of the various subsidiary subjects included in the course. When the subject admits of it, laboratory work will form an essential part of the examination. Lastly, each candidate will be required to work out a design, with specifications and estimates, from data which will be supplied. Such examinations should test a student's real knowledge of a subject, and his power of application to the solution of the problems which arise in every-day life.

The evening classes of the College are conducted chiefly according to the arrangements of the Science and Art Department, and of the City and Guilds of London Institution, and they are arranged in the following courses: (1) Mechanical Engineering; (2) Naval Architecture; (3) Electrical Engineering; (4) Architecture; (5) Building Construction; (6) Mining; (7) Metallurgy; (8) Agriculture; (9) Chemical Industries; (10) Textile Industries; (11) Art Industries; (12) Commerce. In each of these departments there are two grades of certificates, senior and junior, the latter being within the reach of all apprentices. Students who have obtained the senior certificate for the evening classes may obtain the diploma for the day curriculum by attending the third year's course in the corresponding department of the curriculum and passing the necessary examinations. In connection with both the day and evening classes of the College, there are a considerable number of scholarships and bursaries; and in addition the governors have power to remit in whole or in part the fees of artisans and others who are desirous of attending the day classes, and require aid for obtaining the education therein provided. In order to encourage systematic study this privilege will only be afforded to students who have obtained the senior certificate of the College. Arrangements are thus made which should enable all really deserving students to pass from the lowest evening class to the highest classes at the College, or the University; for the students who obtain bursaries will have the option of going to the University or of remaining at the Technical College.

Allan Glen's School is being considerably enlarged, and new class-rooms, drawing-offices, and workshops are being added, and the curriculum of the school has been re-written to suit these enlargements. The elementary department is being gradually curtailed, and will ultimately be dropped, so as to allow of the whole space being available for the secondary department. In this department there are five classes, in the first three of which are given the elements of a good general education, with the scientific side more fully developed than is the case in ordinary schools. In the fourth and fifth classes the work is of a more special nature, and in the last year the attention of the students is directed either to mechanical and electrical engineering or to chemistry. By the time they have completed the course, they ought thus to be in a position to enter on their apprenticeship in the workshops with advantage to themselves, as well as to their employers.

During the past year the number of students who attended the day classes of the College was 168, and the evening classes 1771, and the number of scholars in Allan Glen's School was 439, or a total of 2378, which shows that technical education is being taken advantage of to a considerable extent in Glasgow. One good feature in the arrangement of the College is that advantage is taken of other institutions in so far as their classes can be utilized for the different curricula. For instance, in the day classes the University, and in the evening classes the Athenæum and School of Art and Haldane Academy, make up some of the deficiencies of the Technical College. The resources of each institution are thus fully utilized, and there is no unnecessary waste of energy or money in maintaining duplicate classes.

HENRY DYER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DEPARTMENT OF SCIENCE AND ART.—The following is the list of candidates successful in the competition for the Whitworth Scholarships and Exhibitions, 1888:—1. Scholarships, tenable for three years (£125 a year each): Jas. Whitaker, 22, student, Nelson, Lancashire; James Mair, 22, engineer, Glasgow; C. Humphrey Gilbert, 22, engineer student, Nottingham; John Calder, 21, mechanical engineer, Glasgow. 2. Exhibitions, tenable for one year (£100 each): Harry Bamford, 22, engineering student, Oldham; John Harbottle, 21, draughtsman, Newcastle-on-Tyne; John Taylor, 21, engineer, Glasgow; John Dalglish, 24, mechanical draughtsman, Paisley; Archibald S. Younger, 23, engineer student, North Shields; Joseph Butterworth, 22, engineer, Rochdale; George A. Burls, 21, mechanical draughtsman, Greenwich; Charles H. Kilby, 20, engineer apprentice, Crewe; Charles R. Pinder, 21, engineer student, Bristol; Robert Dumas, 22, engineer, Glasgow; Charles L. E. Heath, 21, fitter apprentice, Devonport; Charles Forbes, 21, engine fitter apprentice, Glasgow; Benjamin Young, 23, electrical engineer apprentice, Belfast; Edward Y. Terry, 23, engine fitter, Devonport; William J. Collins, 23, draughtsman, Woolwich; John H. B. Jenkins, 21, assistant analytical chemist, New Swindon; John I. Fraser, 24, apprentice engineer, Glasgow; Henry E. Cheshire, 24, fitter, Crewe; Oscar Brown, 23, pattern maker, Plumstead;

Henry Elliott, 25, mechanical engineer, Glasgow; (£50 each) Jas. H. Binfield, 23, engineer student, Preston; George U. Wheeler, 20, engineer apprentice, London; William Day, 22, fitter, Wolverton; Samuel Lea, 25, turner, Crewe; Evan Parry, 22, engineer student, Bangor; Thomas O. Mein, 23, engineer, Stratford, E.; Benjamin Conner, 23, apprentice engineer, Glasgow; Thomas J. Bourne, 23, marine engineer, Tunbridge Wells; George Ravenscroft, 25, fitter, Crewe; Thomas F. Parkinson, 22, engineer student, Bury, Lancashire.

The following is the list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships, 1888:—National Scholarships: John B. Coppock, 23, student, Nottingham; James G. Lawn, 20, mining surveyor, Barrow-in-Furness; Herbert Grime, 19, teacher, Manchester; Alfred Stansfield, 17, student, Bradford; John Eustice, 24, engine fitter, Camborne; Edwin Wilson, 19, student, Bradford; Lionel M. Jones, 18, student, Llanelly; Joseph Jefferson, 20, student, Bradford; Henry T. Bolton, 15, student, Newcastle-on-Tyne; Ben. Howe, 18, student, Manchester; John Yates, 20, draughtsman, Manchester; Harry Cavendish, 17, student, Manchester. Royal Exhibitions: Thomas S. Fraser, 17, laboratory assistant, Glasgow; Benjamin Young, 23, electrical engineer apprentice, Belfast; James Harrison, 29, shoemaker (rivetter), Northampton: John D. Crabtree, 16, student, Bradford; Joseph Burton, 19, student, Manchester; John Taylor, 21, engineer, Glasgow; Joseph Husband, 17, student, Sheffield. Free Studentships: Thomas Beatham, 16, student, Newcastle-on-Tyne; Charles H. Kilby, 20, engineer apprentice, Crewe; George H. Gough, 17, student, Bristol; Henry E. Cheshire, 24, fitter, Crewe; Ernest W. Rees, 20, engineer apprentice, Carnarvon; Stanley H. Ford, 17, student, Bristol.

UNIVERSITY COLLEGE, LONDON.—*Gilchrist Engineering Scholarships*.—An entrance scholarship will be offered next month (September). The value is £35 per annum, tenable during two years, and the competition is limited to those who have not previously been students of the College, and who will not complete their nineteenth year before October 1. Every candidate must declare his intention of taking, at least, the two first years of one of the engineering courses, and the second payments will depend upon his success during the first year and the arrangements he makes for the second year's study. The subject of the examination will be mathematics, and any two or more of the following five subjects: mechanics, mechanical drawing, an essay on a given subject, French or German, and the use of tools. A senior scholarship of £80 will be awarded at the close of the session. Candidates must have attended College classes in the following subjects during the whole of the session: applied mathematics, physics, engineering, engineering drawing, and geology. The results of the class examinations will decide the obtainment of the scholarship, providing sufficient merit has been shown to justify the award. There are also entrance and other exhibitions and scholarships given at University College for mathematics, physics, chemistry, classics, German, French, art, Greek, Hebrew, jurisprudence and political economy, philosophy of mind and logic, English literature, medicine, surgery, pathology, and physiology.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for July 1888 contains the following:—On *Haplodiscus piger*, a new pelagic organism from the Bahamas, by W. F. R. Weldon, M.A. (plate 1). The body is ellipsoidal in outline, the antero-posterior diameter being the shortest; in an average specimen the long diameter measured 1·3 mm., the short 1·1 mm. The dorsal surface is slightly convex, the ventral flat, but concave on muscular contraction. There is a cuticular body wall; a muscle layer on the ventral surface; the innermost body layer is a protoplasmic tunic, embedded in which are numerous mucous glands opening through the cuticle. At the anterior end of the body, embedded in the protoplasmic tunic, is the brain. The alimentary tract occupies the centre of the body. It has an oval opening: the tract itself consists largely of protoplasm, which even protrudes, pseudopodia-like, from the oval opening. A pair of ovaries and a testis are present. Yellow cells are scattered quite irregularly throughout the body. The systematic position is doubtful. The author suggests that it may be a free-living Cestode.—On the true teeth and on the horny plates of Ornithorhynchus, by E. B. Poulton, M.A. (plates 2–4). The species of Ornithorhynchus have always been described as without true teeth; but, as is well known, they possess eight horny plates—two on each side of each jaw. True teeth are, however, developed at an early stage beneath the horny plates; there are certainly three on each upper maxilla, and while two only have been proved to exist on each of the lower maxilla, it seems extremely probable that an additional pair will be found. The position and structure of these teeth are eminently mammalian, and are treated of in detail. The horny plates gradually intrude into the alveoli of the true teeth, which, ceasing to come to the surface, are absorbed, so that in the adult animal the bone and the under surface of the epithelium are in close proximity.—Note on the fate of the blastopore in *Rana temporaria*, by H. Sidebotham (plate 5). Differs from Balfour in concluding that the neural folds do not inclose the blastopore, the closure of the blastopore being effected subsequently to the meeting of the neural folds; and still more from Spencer, inasmuch as the anus is not derived from a persistent blastopore, but is formed from an independent proctodæal invagination.—Morphological studies: No. 1, the parietal eye of the Cyclostome fishes, by Dr. J. Beard (plates 6 and 7). Describes the parietal eye in the Ammocœtes of *Petromyzon planeri* in its adult form, also in Myxine.—On some Oigopsid cuttle-fish, by F. Ernest Weiss (plates 8–10). A very interesting study of some Mediterranean cuttle-fish.—On the organ of Verrill in Loligo, by M. Laurie (plate 11). An examination of the structure of this organ proved it to be glandular.

IN the *Journal of Botany* for July, Mr. George Murray begins a list of the Marine Algæ of the exceedingly rich West Indian region; Mr. F. J. Hanbury describes some forms new to Britain of the very difficult genus *Hieracium*; and Mr. W. B. Grove a new genus of Fungi, *Pimina*, belonging to the Hyphomycetes, parasitic on another Fungus on the leaves of passion-flowers near Dublin.

IN the *Botanical Gazette* for June, Mr. Charles Robertson begins a paper having for its object an attempt to explain the origin of the zygomorphic form in flowers, on the principle of natural selection. Herr A. F. Foerste describes a number of structures adapted to cross-fertilization in American flowers; and Mr. F. H. Knowlton a new fossil *Chara* from the Lower Tertiaries in Utah.

American Journal of Science, July.—Upon the relation which the former orbits of those meteorites that are in our collections, and that were seen to fall, had to the earth's orbit, by H. A. Newton. We printed this paper on July 12 (p. 250).—History of changes in the Mount Loa craters (continued), by James D. Dana. This paper deals mainly with Mokuaweoweo, the summit crater of Mount Loa. The history is given of its eruptions from 1832 to 1888, and the subject is illustrated with three plates, giving maps of the island of Hawaii and of Mokuaweoweo with two views of a lava fountain at the eruption of January 1887. The paper is followed by a communication from W. T. Brigham and J. M. Alexander on the summit-crater of Mount Loa in 1880 and 1885.—On an explanation of the action of a magnet on chemical action, by Henry A. Rowland and Louis Bell. These researches have reference to Prof. Remsen's discovery that magnetism has a remarkable action on the deposition of copper from one of its solutions on an iron plate, and to Prof. E. L. Nichols's inquiry into the action of acids on iron in a magnetic field. Their conclusions differ from those of Nichols, inasmuch as they give the exact mathematical theory of the action, while Nichols gives no theory, and does not notice the action of points.—Wave-like effects produced by the detonation of gun-cotton, by Charles E. Monroe. It is suggested that, in the curious phenomena here described, a means may be found for distinguishing between, and perhaps measuring the effects of, different detonating explosives.—A mode of reading mirror galvanometers, &c., by Dr. R. W. Willson. Although less accurate than that of telescope and scale, the method here proposed is stated to be often more convenient.—Bertrandite from Mount Antero, Colorado, by Samuel L. Penfield. The specimen of this rare mineral here studied was selected from some materials collected last summer at Mount Antero, in the search for specimens of phenacite. Its hardness is determined at 6–7, and specific gravity 2·598; while analysis yielded SiO_2, 51·8; BeO, 39·6; H_2O, 8·4; CaO, 1·0.—W. W. Dodge determines some localities of post-Tertiary and Tertiary fossils in Massachusetts; E. O. Hovey describes a Cordierite gneiss from Connecticut; and W. Hallock has a short note on the flow of solids.

THE original articles in the *Nuovo Giornale Botanico Italiano* for July comprise a description, with plate, of a singular proliferous specimen of an *Agaricus*, by Signor U. Martelli; a summary of the characters of twenty-two of the principal varieties of the vine grown in the neighbourhood of Arezzo, by Signor L. Macchiati; and contributions to the flora of Massana, by Signor U. Martelli. In the Reports of the Proceedings of the Italian Botanical Society, is an interesting article by Signor G. Arcangeli, on Kefir, an alcoholic and effervescing drink, prepared in the Caucasus by the fermentation of cows' milk. The author confirms the statement of previous observers that in the fermented liquid there are always found a *Saccharomyces* very closely allied to *S. cerevisiæ*, and several Schizomycetes. The organism of the latter class described by previous writers as *Dispora caucasica*, and regarded as peculiar to this kind of fermentation, he identifies with *Bacillus subtilis*, which is accompanied by *B. acidi lactici*. Signors Martelli and Macchiati contribute papers on the freshwater diatoms of the district of Modena.

Revue d'Anthropologie, troisième série, tome iii., quatrième fasc. (Paris, 1888).—Continuation of the stratigraphic palæontology of man, by M. M. Boule. In this essay the writer treats of the most recently established conclusions regarding the chronological order of the erratic deposits of the valleys of the Rhone, the Saône, and the Ain, which belong to the Quaternary and the Upper and Middle Pliocene ages. He agrees with the generally accepted opinion that the existence of interglacial deposits has been established by scientific evidence, while the identity of the animals and plants everywhere found in these beds prove that they must be nearly contemporaneous. The discovery last year by M. Tardy of a stone implement of the Saint-Acheul type, which was embedded in the alluvial banks of the Ain, and near intact moraines, would seem to connect the presence of man with one of these interglacial periods, while Dr. Penck has shown that each retrogression of a glacier corresponds to a period of alluvial deposit in valleys. Passing from the Alps to the Pyrenees, M. Boule, again following the same authority, shows that, while in the former region there is at many points evidence of repeated glaciation, in the latter the moraines rest directly on ancient rocks. Numerous other difficulties surround the question of glaciation in the Pyrenean range, and the interest of M. Boule's essay depends largely upon the care with which he has sifted the evidence derived from the numerous writers to whom he refers; and the English student will find this section of his work a useful guide to the bibliography of the subject in regard to Auvergne, as well as to the Swiss and French Alps. —The Afghans, by M. L. Rousselet. The excessive admixture of races which is to be found in the land of the Afghans is considered by the author as one of the most curious features of their ethnic history. The physical characteristics of the Afghans of Cabul and Candahar point to an Aryan origin, and would seem to ally them with the Sikhs and Rajputs of North-Western India; while the occasional appearance among the inhabitants of the larger cities of what is commonly known as the Jewish type of face is, according to M. Rousselet, sufficiently explained by the important part which from the earliest period of Islamism Arabs have taken in converting the Afghans to the faith of the Prophet. From Chinese authorities we learn, moreover, that before the middle of the sixth century invaders of a Turcoman race had entered the land of the Afghans, and subjugated some of its tribes. In the tenth century another Turcoman invasion confirmed the domination of the Mohammedans, and since then the Koran has constituted the national code; but, although of the Sunnite sect, the upper classes adhere to the tongue of their heretical neighbours, the Chiite Persians. The theory advocated by many English writers, that the Afghans are descended from the ten lost tribes of Israel, is treated by the writer as unworthy of all serious consideration. He cannot see in this people, of variously composed ethnic elements, anything that demands the establishment of a far-fetched theory to explain their history or character; but he thinks that, in spite of their want of national cohesion, they may—through their love of freedom, the independence secured to them by their geographical position, and their warlike instincts—at no very distant date be called upon to decide the fate of India.—Contributions to the history of anomalous muscles of the neck and back, by M. Ledouble. In this paper the examples cited of such anomalies have been principally taken from the printed reports of Mr. John Wood, Profs. Macalister, Flower, Huxley, &c.—Notes on the Département de l'Aïn, by Dr. Aubert. These notes supply an interesting account of the mode of formation and nature of the innumerable ponds and marshes which long gave so peculiar a character to the districts of Dombes, Bresse, and Bugey, in which the great preponderance of standing waters has been for centuries a source of poverty and disease to the unfortunate inhabitants. The existence of such vast areas of more or less deep still-waters is dependent upon a geological cause which must always have been in force, since they owe their origin to the impermeability of the soil beneath them; but it would appear that prior to the fourteenth and fifteenth centuries, when the process of so-called *evolage* and *assec* was first established in these districts, the country was healthier and more populous than it has been in more recent times. This system—which consists in drawing off the waters of certain ponds every third year, and sowing the wet ground with barley and oats after the vast accumulations of fish have been cleared off—naturally gives rise to mephitic effluvia, inducing malarian diseases. These and other evils due to the system of *evolage* had the effect of gradually reducing the population to twenty-four inhabitants to the square kilometre, and giving an average longevity of less than twenty-one years. This state of things, which reached its maximum about the middle of this century, has been steadily improving since the draining of the ponds has been systematically taken in hand. At the present time 6000 hectares of land have already been recovered, and, while fevers have diminished, the tables of conscription show that, whereas in some cantons the numbers of rejections among the recruits were from 80 to 90 per cent. between 1837 and 1847, they had fallen between 1872 and 1886 to below 10 per cent. Dr. Aubert's notes supply an interesting commentary on the practical importance of applying scientific knowledge to the elucidation and modification of the physical condition of the soil, even where this seems to be dependent on apparently unalterable geological causes.—The formula for reconstructing the human figure in accordance with dimensions of the long bones, by M. Topinard. This is little more than a critique of Dr. Beddoe's paper on the stature of the ancient races of England.

Rivista Scientifico-Industriale, June 30.—Note on microscopy (continued), by Prof. Aser Poli. After a rapid survey of the various improvements or modifications introduced by Huyghens, Campani, Ramsden, and other oculists, the author proceeds to examine critically the suggestions recently made by Mr. E. M. Nelson in connection with Campani's eye-piece (Journal of the Royal Microscopical Society, 1887, p. 928). By a simple calculation, in which numerals are substituted for letters in the well-known formula, he shows that the theory is directly opposed to Mr. Nelson's statement. The assertion is also questioned that his theoretical conclusions have been confirmed by practical experiment.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 13.—M. Janssen, President, in the chair.—Remarks in connection with the "Connaissance des Temps pour 1890" (212th year of publication), presented to the Academy by M. Bouquet de la Grye. Amongst the improvements and additions made to this volume are: the semi-diameter of the sun, the duration of its transit, the parallax and aberration for every day in the year, the conditions of visibility of Saturn's ring, and tables for calculating the phases of the solar eclipses for every point on the surface of the globe. By means of certain typographical expedients, all these additions have been made without increasing the size of the volume.—On a general property of elastic solid bodies, by M. Maurice Lévy. A demonstration is offered of the following theorem: If two systems of forces in equilibrium be successively applied to an elastic solid body, whether isotropous or crystallized, free or not (and consequently to a system of similar bodies connected together in any way), then the sum of the work produced by the forces of one of these systems, for the elastic displacements due to the other, is equal to the sum of the work produced by the forces of the latter for the elastic displacements due to the first.—On the influence exercised by antipyretic substances on the quantity of glycogen contained in the muscles, by MM. R. Lépine and Porteret. In a previous note (*Comptes rendus* for April 3, 1888), the authors showed that antipyretic substances act as an impediment to the transformation of the hepatic glycogen into sugar. They now give the results of their further researches on the influence exercised by the antipyrine and acetanilide in determining

the proportion of glycogen contained in the muscles. Compared with healthy animals, those intoxicated with these substances have an excess of muscular glycogen varying from 28 to 30 per cent.—On the precautions required to be taken in order to secure good photographs of lightning, by M. Ch. Moussette. An experiment is described, which is intended to show that the defective photographs of electric discharges are mainly due to the vibrations communicated to the apparatus by the trembling of the ground, the force of the wind, or the crash of the thunder. Hence, in order to obtain good impressions, these disturbing elements should be neutralized to the utmost.—Observations of Brooks's new comet, made at the Paris Observatory with the equatorial of the West Tower, by M. G. Bigourdan. This comet was discovered by Mr. Brooks at the new Observatory of Geneva, State of New York, on August 7, 1888. It was faintly visible in Paris on August 9, and the present observations were taken on the three following days.—On amorphous antimony, by M. F. Hérard. The author has succeeded in obtaining directly the allotropic modification of antimony indicated by Gore, and resulting from the decomposition of a chloride, bromide, or iodide of antimony. It takes the form of a gray powder containing 98·7 per cent. of antimony, with density 6·22 at 0° C., and point of fusion about 614°, whereas crystallized antimony melts at about 440°.—On four new titanates of zinc, by M. Lucien Lévy. Since his communication (*Comptes rendus*, vol. cv. p. 378) on a trititanate of zinc obtained by means of fluorides, the author has obtained four other titanates by fusing titanic acid with mixtures of zinc and potassa sulphates. These titanates are here described, analyzed, and reduced to their proper formulas.—M. A. Duponchel has a note on a 24-years' cycle of periodicity in the oscillations of temperature on the surface of the globe, based on the records of mean temperatures in Paris from the year 1765 to 1783, and from 1804 to the present time.

August 20.—M. Janssen in the chair.—Note on the adoption of a legal hour in France, by M. Bouquet de la Grye. The Commission appointed in January by the Bureau des Longitudes to inquire into the best means for establishing a common legal hour sent in its Report on June 4, and the Bureau has now invited the Minister of Public Instruction to support a project of law intended to give effect to the recommendations of the Commission.—On inoculation against Asiatic cholera, by Dr. N. Gamaleïa. The substance of this paper has already appeared in the last number of NATURE (p. 395).—Observations of Faye's comet, rediscovered at Nice on August 9, by M. Perrotin. The observations here recorded were taken on August 9 and 10, when the comet was faintly visible, showing a slight central condensation with enveloping nebulosity of circular form, and nearly 1′ in extent.—Observations of Brooks's new comet, made at the Observatory of Nice with the 0·38m. Gautier equatorial, by M. Charlois. The observations are for August 9 and 10, when the comet had a brightness equal to that of a star of the 9th or 10th magnitude, with a faint tail about 5′ long; position-angle, 270°.—On the satellites of Mars, by M. E. Dubois. The two satellites discovered by Asaph Hall on August 11 and 17, 1877, have since been observed by several astronomers, and their elliptic elements recorded in the *Annuaire du Bureau des Longitudes*. How have they hitherto escaped observation, notwithstanding the favourable conditions presented for detecting them? It is suggested that Phobos and Deimos, as they have been named, may perhaps be two small members of the telescopic planetary zone between Mars and Jupiter, which have recently been drawn within the influence of Mars.—Provisional laws determining the subsidence of the land in certain parts of France, by M. C. M. Goulier. A comparison of the altitudes recorded by former and recent surveys seems to indicate a progressive sinking of the surface in the direction from south to north, where the discrepancy amounts to 0·78m. Although the available data are still insufficient to determine the laws regulating this vertical movement, it appears no longer doubtful that subsidence and upheaval take place not only along the seaboard, but also in the interior of the continents to a much greater extent than has hitherto been suspected.—On the vapour-tensions of solutions made in alcohol, by M. F. M. Raoult. His further experiments here described enable the author to generalize the law already formulated by him (*Comptes rendus*, May 23, 1887) to the effect that one molecule of a non-saline fixed substance dissolved in 100 molecules of any volatile liquid, diminishes its vapour-tension by a constant quantity corresponding to about 0·0105 of its value.—Experiment on the treatment of the potato disease, by M. Prillieux. A mixture of 6 parts of the sulphate of copper and 6 of lime to 100 of water (the "Bordeaux broth") has been applied with complete success to some potato plants at Joinville-le-Pont attacked by Peronospora. But to be efficacious the remedy must be applied either as a prophylactic or in the early stages of the disease.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Building of the British Isles: A. J. Jukes-Browne (George Bell).—Annales de l'Observatoire Impérial de Rio de Janeiro, tome iii.; Passage de Vénus, 1882 (Rio de Janeiro).—Planetary and Stellar Studies: J. E. Gore (Roper and Drowley).—History of Modern Philosophy; Descartes and his School: K. Fischer, translated by J. P Gordy (Unwin).—Encyklopædie der Naturwissenschaften, Erste Abthg., Liefg. 55, 56, 57; Zweite Abthg., Liefg. 48 (Williams & Norgate).—iii. Jahresbericht (1887) der Ornithologischen Beobachtungstationen im Königreich Sachsen: Dr. A. B. Meyer und Dr. F. Helm (Dresden).—The Species of Ficus of the Indo-Malayan and Chinese Countries, Part 2: G. King (Calcutta).—A New Era of Thought: C. H. Hinton (Sonnenschein).—The Nature of Harmony and Metre: M. Hauptmann; translated and edited by W. E. Heathcote (Sonnenschein).—Magnetical and Meteorological Observations made at the Government Observatory, Bombay, 1886 (Bombay).—The Principles of Manure and Luxuriance in Plant Life: W. K. Fulleylove (Birmingham).—A Propos des Chatiments dans l'Éducation: F. Hément (Paris).—Inō Chūkei, the Japanese Surveyor and Cartographer: C. G. Knott.—Anniversary Address delivered to the Royal Society of New South Wales, May 2, 1888: C. S. Wilkinson.—Proceedings of the Liverpool Naturalists' Field Club, 1887 (Liverpool).—Boletin de la Academia Nacional de Ciencias en Córdoba, Tomo x. Ent. 2a (Buenos Aires).—Third Annual Report of the City of London College Science Society, 1887–88 (London).—Abstract of Proceedings of the South London Entomological and Natural History Society, 1888 (London).—Journal of Physiology, August (Cambridge).

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